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EVALUATION OF GROUNDWATER RESOURCES IN THE REGINA AREA

INTERIM REPORT

by

G. van der Kamp and H. Maathuis

SRC Technical Report No. 175

Publication R-844-6-B-85 December, 1985

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HIGHLIGHTS

In the Regina area groundwater has been used since the end of the nineteenth century for domestic and industrial water supply. Until 1955 it was practically the only source of water for the City of Regina.

During recent decades the total groundwater pumping rate has averaged about ten million cubic metres of water per year (10,000 dam^3 or 8100 acre-feet per year). The recharge rate and the available reserves are large enough that this rate of pumping can be maintained for many years to come. Groundwater therefore is an important and reliable water resource for the Regina area.

Water levels in the Boggy Creek, Mallory Springs and Mound Springs well fields have been stable for many years. These well fields therefore appear to be operating on a sustained yield basis.

Groundwater levels in the "Regina Aquifer" (roughly the Regina urban-industrial area) have dropped by about 5 to 6 metres since 1940 and are declining steadily. The aquifer reserves are slowly being depleted.

Contamination is of major concern with regard to long-term groundwater use in the Regina area. The sands and gravels of the Condie Moraine are especially vulnerable to contamination. On the long term contaminants in the Condie Moraine sands and gravels can be expected to move down to the underlying aquifers, which are the main source of groundwater.

Effective management and protection of the groundwater resources can only be done on a regional basis, taking into account the interaction of groundwater and surface water.

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ACKNOWLEDGEMENTS

Messrs. W.R. Masson and A. Ring, Public Works and Engineering Department, City of Regina, are gratefully acknowledged for their discussions on Regina's drinking water supply. They also provided copies of technical reports, copies of production well construction and water quality data, and well field and well production data.

Mr. V.G. Beckie, Beckie Hydrogeologists Ltd., Regina, contributed to this report through many discussions and by providing copies of technical reports.

Discussions with Mr. D. Kent, Clifton Associates Ltd., Regina, were very useful and provided clarification on technical details in reports prepared by Clifton and Associates Ltd.

Messrs. E.J. Jaworski, D.A. Zlipko and Mrs. T. Warkentin, Saskatchewan Research Council, are gratefully acknowledged for assisting in the compilation and preparation of data.

Messrs. U. Roeper and H. Martin, Saskatchewan Water Corporation, are thanked for providing data on groundwater withdrawals in the Regina area.

Saskatchewan Urban Affairs, Community Planning and Services Branch, made duplicate positives available of maps and cross sections prepared by Christiansen (1979a).

1. INTRODUCTION

Groundwater has constituted an important source of water for the City of Regina since the turn of the century. In fact, until the surface water supply from Buffalo Pound Lake started in 1955, water from wells was practically the sole source of water for the city. One might in fact wonder whether the city could have grown as much as it has if it had not been for the occurrence of high-yield aquifers. The available groundwater supply in the area is about 10,000 dam^3 per year, and this amount of water will always have a considerable economic significance in a water-short region such as southern Saskatchewan.

In view of the importance of groundwater for Regina it is not surprising that groundwater resources of the area have been the subject of numerous studies, (see Section 10, References). Chief among these were those of Wynne-Roberts (1912), Hill, Wynne-Roberts and Simpson (1930), and Lissey (1962). The hydrogeology of the area is very complex, so that in spite of these earlier studies, the groundwater resources of the area cannot be said to have been fully evaluated. Major questions remain as to the extent and continuity of aquifer zones, recharge rates and potential yields, long-term water-level changes due to pumping, and potential for contamination.

In response to this need for a better understanding of groundwater in the Regina area, the Saskatchewan Research Council carried out earlier studies, culminating in reports by Meneley and Christiansen (1975) and Schneider (1978). These reports provided an updated analysis of stratigraphy in the Regina area and a first attempt at obtaining a quantitative groundwater evaluation by means of a computer model.

Christiansen (1979a) described the geology of the Regina-Moose Jaw region. The stratigraphy which he established forms the basis for the hydrogeological description given in this report.

The present study was initiated in response to a request for advice on licensing of groundwater withdrawals in the Regina area. It was envisioned that Schneider's (1978) computer model could be used to evaluate the groundwater potential of the Regina area; however it soon became clear that much more data would be required to arrive at a reliable evaluation of the groundwater resources. The present report provides a compilation and analysis of the available data.

This report has been titled "Interim" because some important questions remain with regard to hydrogeology, flow, and groundwater quality in various parts of the Regina area. Most of these questions can probably be answered fairly quickly with more field investigations and data gathering.

Planning for a follow-up report is already underway. It is planned that this "final" report will be completed by the end of 1986 and that it will provide a much more detailed and complete evaluation of the groundwater resources in the Regina area. Readers will probably note missing elements in the present report such as a lack of detailed geological cross-sections, missing groundwater withdrawal data, etc. These will be remedied as much as possible by searching out of additional data, further field work and by compilation and analysis of all the available data.

The focus of both the interim report and the future follow-up report is regional in nature. No attempt has been made to go into the full detail of particular sites such as the Regina landfill.

An important objective of this report is to collect, and check all available data and to compile these data in a uniform format. These data collections, presented in maps and appendices, should provide useful background material for many local or regional studies in the future.

2. STUDY AREA

For the purpose of the present study, the Regina area has been defined as the area enclosed by the 50° 15' to 50° 50' North Latitude and 104° to 105° West Longitude. This area roughly corresponds to the area covered by Ranges 15 to 22, Townships 15 to 21, West of the Second Meridian. The northern limit of the study area is formed by the Qu'Appelle River.

Climatic data of the study area have been provided by Environment Canada (1982) and by New grade Energy (1985b, page 3-2). The mean annual precipitation at Regina airport is 384.0 mm, 70 percent of which falls as rain and 30 percent as snow. The topographical setting of the area can be derived from 1:250,000 and 1:50,000 topographical maps and is not further discussed.

3. GEOLOGY

3.1 Introduction

The geological setting of the Regina area was discussed and shown in the form of maps and cross sections by Christiansen (1961, 1971, 1979a), Lissey (1962), Meneley and Christiansen (1975) and Schneider (1978).

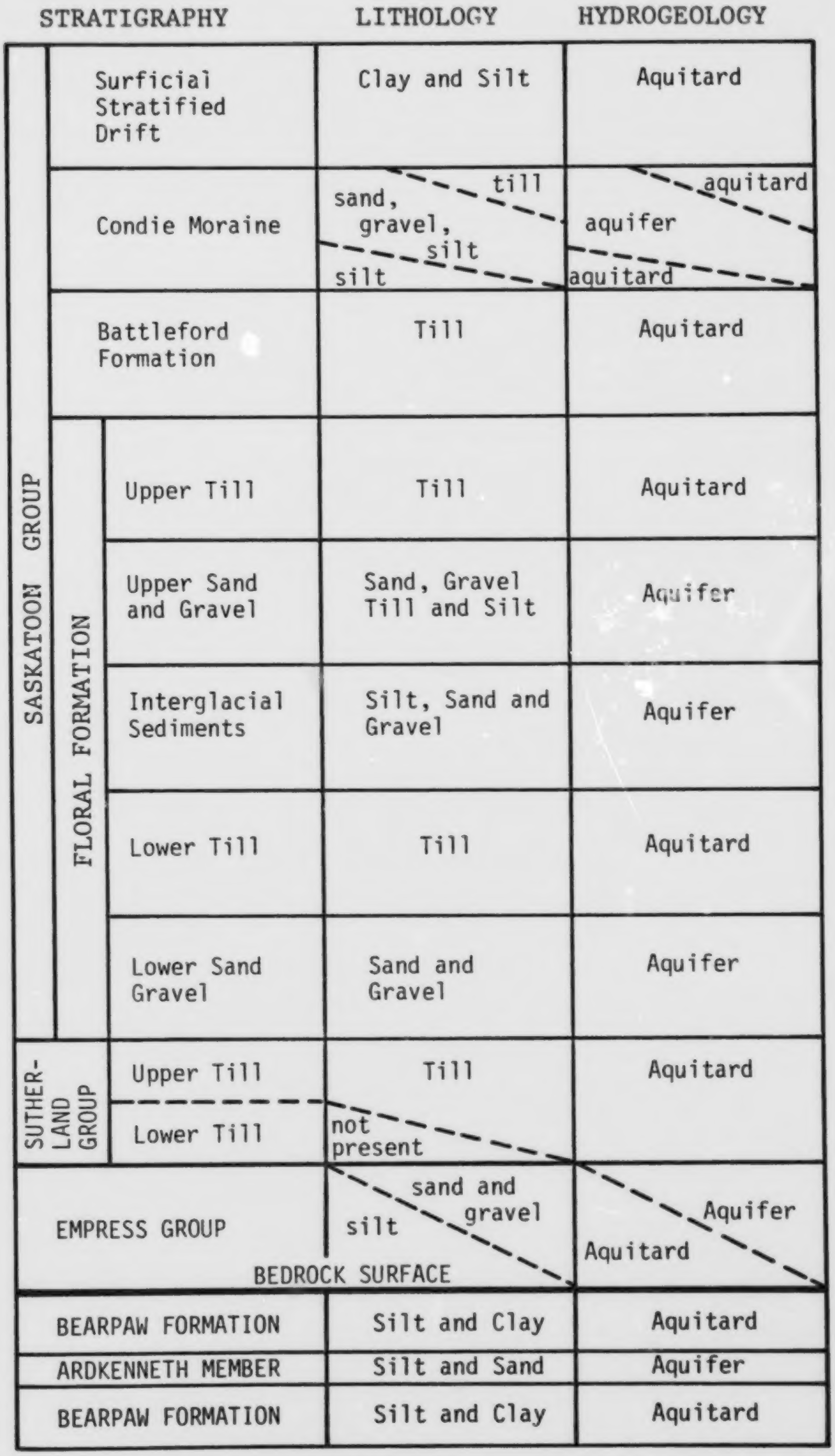
The present report is based on the geological framework of the Regina area as established, discussed, and also presented in the form of cross sections and maps, by Christiansen (1979a).

The geological setting of the Regina area, the stratigraphical units and their lithological characteristics, are illustrated schematically in Figure 1. The geological framework is shown in the form of three cross sections, which were prepared by Christiansen (1979a, drawings 0016-003-05/06/16). These cross sections are included in Appendix A.

A large number of additional cross sections, more specifically showing the geological setting from a hydrogeological point of view, are in preparation. These cross sections will be presented in a later report. At that time also an updated, and metric, map of the bedrock geology and bedrock surface topography will be available.

3.2 Bedrock Stratigraphy

The bedrock stratigraphy within the study area was discussed by Christiansen (1961, 1971, 1979a). The Bearpaw Formation is the single most important bedrock unit in the study area since it forms the bedrock surface throughout this area. The Cretaceous Bearpaw Formation consists



STRATIGRAPHY			LITHOLOGY	HYDROGEOLOGY
SASKATOON GROUP		Surficial Stratified Drift	Clay and Silt	Aquitard
		Condie Moraine	till sand, gravel, silt silt	aquitard aquifer aquitard
		Battleford Formation	Till	Aquitard
	FLORAL FORMATION	Upper Till	Till	Aquitard
		Upper Sand and Gravel	Sand, Gravel Till and Silt	Aquifer
		Interglacial Sediments	Silt, Sand and Gravel	Aquifer
		Lower Till	Till	Aquitard
		Lower Sand Gravel	Sand and Gravel	Aquifer
SUTHERLAND GROUP		Upper Till	Till	Aquitard
		Lower Till	not present	
EMPRESS GROUP			sand and gravel silt	Aquifer Aquitard
BEDROCK SURFACE				
BEARPAW FORMATION			Silt and Clay	Aquitard
ARDKENNETH MEMBER			Silt and Sand	Aquifer
BEARPAW FORMATION			Silt and Clay	Aquitard

Fig. 1 Schematic geological and hydrogeological setting of the Regina area. (Stratigraphy after Christiansen, 1979a)

of marine, gray, non-calcareous silts and clays and may be up to 244 metres thick. Locally it also may include the Ardkenneth Member; a sand interbed consisting of fine-grained sands and silts.

3.3 Quaternary Stratigraphy

The Quaternary stratigraphy, in ascending order, may include the Empress, Sutherland and Saskatoon Groups (see Figure 1). A brief description of these Groups is given below.

3.3.1 Empress Group

The Empress Group is composed of sand, gravel, silt and clay of fluvial, lacustrine and colluvial origin that overlies marine Cretaceous bedrock and non-marine Tertiary bedrock, and underlies till of Quaternary age in southern Saskatchewan (Whitaker and Christiansen, 1972).

Christiansen (1979a) indicates the Empress Group in the study area can be subdivided into areas where it mainly consists of silts and where it mainly is composed of sand and gravel. He also shows the extent and thickness of the Empress Group (Christiansen, 1979a, drawing 0016-003-19).

3.3.2 Sutherland Group

In the study area the Sutherland Group (Christiansen, 1968a) is composed of zero to 64 metres of till and minor amounts of stratified drift. Christiansen (1979a) indicates that in the area only the Upper Till of the Sutherland Group is present.

3.3.3 Saskatoon Group

In the study area the Saskatoon Group, in ascending order, may include the Floral and Battleford Formations, the Condie Moraine, and Surficial Stratified Drift.

The Saskatoon Group and Floral and Battleford Formations were formally defined by Christiansen (1968a,b).

Christiansen (1979a) informally subdivided the Floral Formation in the study area, in ascending order, into:

- Lower Floral Sand and Gravel
- Lower Till
- Interglacial Sediments
- Upper Floral Sand and Gravel
- Upper Till

The following description of these units is a shortened version of that provided by Christiansen (1979a):

> "The Lower Floral Sand and Gravel which lies between the Sutherland Group and the Lower Till of the Floral Formation, is composed of sand and gravel with interbeds of silt and till.
>
> The Lower Till of the Floral Formation lies between the Lower Floral Sand and Gravel and Interglacial Sediments or between the Lower and Upper Floral Sand and Gravel. Where the Lower Floral Sand and Gravel is missing beneath the Interglacial Sediments, the Lower Till lies between the Sutherland Group and these Interglacial sediments.
>
> The Interglacial Sediments, which are between the Lower and Upper Tills or between the Lower Till and Upper Floral Sand and Gravel, are composed of zero to 112 metres of fossiliferous, carbonaceous, silt, sand and gravel. These sediments are restricted to the collapse structure under the City of Regina (Christiansen, 1979a, drawing 0016-003-01).
>
> The Upper Floral Sand and Gravel lies between the Interglacial Sediments and the Upper Till. In addition to sand and gravel, this unit is composed also on interbedded till and silt.
>
> The Upper Till of the Floral Formation, which lies between the Interglacial Sediments or Upper Floral Sand and Gravel and the

> Battleford Formation is composed of till and minor amounts of sand, gravel and silt."

The Battleford Formation is composed of mainly soft, unjointed, and unstained till and generally is less than 1.5 metres thick.

Since there is insufficient information to trace the Lower and Upper Tills of the Floral Formation, these units are not shown on the cross sections. Also, since the Battleford Formation is generally too thin to be shown it has not been identified on the cross sections.

The Condie Moraine was named and first described by Christiansen (1961). Christiansen (1979a) describes the Condie Moraine in more detail:

> "The Condie Moraine consists of a core of sand and gravel flanked to the south by an apron of sand and silt. The apron is composed of a lower wedge of sand and an upper blanket of silt, both of which become progressively thinner and finer grained to the south. Most of the sand and gravel core of the Condie Moraine is covered by zero to 7 metres of till deposited presumably by a slight re-advance of the glacier. After the glacier retreated, the Moraine was covered with Lake Regina silt and clay."

In the context of the present report the most important Surficial Stratified Drift deposit in the study area is the Regina Clay. Clays and silts of the Regina Clay were deposited into Lake Regina during the final deglaciation of the area.

3.4 History of Glaciation and Deglaciation

The history of glaciation and deglaciation has been described by Christiansen (1961, 1979a,b) and will not be further discussed in this report.

3.5 Surficial Geology

The surficial geology has been discussed by Christiansen (1961, 1979a). Maps showing the surficial geology have been presented by Christiansen (1961), Mollard and Associates Ltd. for Saskatchewan Urban Affairs (1979), and the Saskatchewan Research Council (1985). The Saskatchewan Research Council's map has been included in the back of this report (MAP NO. 9).

4. METHODOLOGY OF GROUNDWATER RESOURCES EVALUATION

4.1 Identification of Principal Aquifer Zones

Based on the geological setting the following aquifer zones, in decending order, can be distinguished (see Figure 1):

- an aquifer formed by Condie Moraine sands and gravels.
- aquifers formed by the Upper Floral Formation sands and gravels.
- an aquifer formed by the Interglacial Sediments.
- aquifers formed by the Lower Floral Formation sands and gravels.
- aquifers formed by sediments of the Empress Group.

The aquifer zones are discussed in more detail in the following section, except the aquifers formed by Empress Group sediments. The latter are not discussed because little information is available and in the context of the present study these aquifers are of minor importance. For the purpose of the discussions in this report the waterbearing zones formed by the Upper Floral Formation Sands and Gravels and the Interglacial Sediments have been combined. Maps (see Maps No. 1,2,4,5) have been prepared showing the extent, depth to and thickness of the different aquifer zones.

Aquitards are formed by the silts and clays of the Regina clay, silts of the Condie Moraine and tills of the Saskatoon and Sutherland Groups. A map (see Map No. 3) has been prepared showing the thickness of the aquitard between the sands and gravels of the Condie Moraine and the Upper Floral Formation Sands and Gravels. The silts and clays of the Bearpaw Formation form an impermeable base as far as groundwater flow above it is concerned.

4.2 Groundwater Data

An important question with regard to the groundwater resources in the Regina area concerns possible changes of water levels since groundwater withdrawals started, around the turn of the century. Such water level changes or lack thereof have an important bearing on estimates of the long-term yields of various aquifers.

An effort has therefore been made to collect and document all available data on groundwater use and static water levels, even when these data are of low reliability, as is particularly the case for much of the earlier data.

In Appendix B an inventory of water level data, arranged according to land location is presented. These data have been compiled from Saskatchewan Department of the Environment Groundwater Data Reports and various technical reports. The source of the information is indicated in the Appendix.

Yearly groundwater withdrawal data are presented in Appendix C. These data have been compiled from data provided by the City of Regina and by the Saskatchewan Water Corporation.

A related question concerns the water quality in the different aquifer zones and the changes of groundwater quality that may have occurred since withdrawals and urban-industrial activities started. Data on groundwater quality therefore have been compiled. Analyses with an error in the ionic balance of less than five (5) percent have been tabulated and, arranged according to land location, are presented in

Appendix D (Table D-1). Based on the present knowledge, this table also indicates from which aquifer zone the sample was taken. The groundwater quality data presented were obtained from the Saskatchewan Research Council's groundwater quality data base, Rutherford (1966), the City of Regina, and from various consulting reports. The source of the water quality data is also indicated in Table D-1.

The groundwater quality data compiled and presented by Lissey (1962) appeared not to be compatible with the quality of the analyses presented in Table D-1. The data presented by Lissey often lack values for major constituents and calcium and magnesium, bicarbonate and carbonate, were expressed in term of hardnesses and alkalinities, respectively. However, since these data are of some historical value, a listing of Lissey's most complete analyses is provided in Table D-2, Appendix D.

Selected water quality data have been presented on Maps No. 6,7, and 8, in the form of the total sum of ions (also called total concentration in this report) and water type.

Well construction data, water quality data and Piper plots for the production wells the City of Regina uses or has used for its drinking water supply have been compiled in an open-file report by Maathuis and Van der Kamp (1985). A list of the City of Regina production wells and location maps are presented in Appendix E.

4.3 Naming of Aquifers

Over the years, a variety of names have been used for various combinations of aquifer zones in the Regina area. As a result there is now some confusion as to what names such as "Regina Aquifer" mean. Much of this confusion has come about because aquifer names were used even though the extent and hydraulic continuity of the aquifer zones were not clearly established.

In the present report naming of aquifers has been avoided if the extend and hydraulic continuity of the aquifer zones in question are substantially uncertain. The naming guidelines suggested by Jorgensen and Signor (1984) have also been used. These authors essentially suggest that geologic-age terminology or stratigraphic terminology should not be used in aquifer names.

5. GROUNDWATER RESOURCES OF THE CONDIE MORAINE

5.1 Extent and Divisions of Condie Moraine

The extent of the Condie Moraine is shown on Map No. 1 as well as the depth to, thickness and saturated thickness of Condie Moraine sands and gravels, and silts. For the purpose of this report the Condie Moraine has been subdivided into three areas (see Map No. 1):

- an area where the Condie Moraine consists of silts.
- an area where the Condie Moraine mainly consists of sands and gravels, covered by till and clays of the Regina Clay.
- an area where the Condie Moraine consists of sands and gravels at the ground surface.

This differentiation is necessary to separate aquifers from aquitards, and also has an important bearing on recharge to the aquifer and on water quality within the aquifer.

5.2 Definition of Condie Aquifer

In the literature confusion exists regarding the name of the aquifer formed by the saturated portion of the Condie Moraine sands and gravels. For example, the western portion of the aquifer was called the Regina A - Zone Aquifer (Lissey, 1962). The eastern portion was included in the Avonhurst Aquifer (Lissey, 1962), but portions of the aquifer in this area were also given local names such as the Pilot Butte Aquifer (Beckie Hydrogeologists, 1985).

From a geological point of view the sands and gravels of the Condie Moraine form one, well defined, continuous unit. Water level data also indicate that there is hydraulic continuity throughout the sands and gravels. Consequently, the saturated portion of the sands and gravels of the Condie Moraine can be defined as a single aquifer. Therefore, the name Condie Aquifer has been assigned to the saturated portion of these sands and gravels. Clifton Associates (1985) also used the name Condie Aquifer in the same sense as is done in this report.

The Condie Aquifer, in various combinations, is overlain by unsaturated sands and silts of the Condie Moraine, till of the Battleford Formation and clay of the Regina Clay.

The Condie Aquifer is bounded below by an aquitard formed by tills of the Battleford and Floral Formations.

5.3 Water Levels in the Condie Aquifer

Water level data for the Condie Aquifer are given in Appendix B and recent data are plotted on Map No. 6. The plotted data include both approximate water levels (unsurveyed datum) and exact levels (surveyed datum) for the period 1970-1985. During this period there were no major changes of water level, as indicated by the relatively constant static water levels in well R2 (W2-20-18-12-NE) since 1960. Also indicated on the map are stream elevations at the points where the 25 foot (7.62 m) contours on the 1:50,000 topographic maps cross the stream channels. The surface water data are included because it appears that the groundwater in the Condie Aquifer interacts actively with Boggy Creek, Wascana Creek, and their tributaries.

Hydraulic head contours have been sketched on Map 6, based on the water level data, stream bed elevations and topographic contour lines. Where permanent streams cross the Aquifer the hydraulic head contours have been assumed to be continuous with surface-water elevations. Areas where the hydraulic head contours are conjectural due to lack of data are indicated by question marks. In particular the degree of hydraulic connection between the Condie Aquifer and Boggy Creek in the area of the Condie Reservoir is uncertain. Water level data are also very sparse for eastern and western ends of the Aquifer.

It is possible that seasonal changes of water-level may be as much as one or two metres, particularly where the Condie Aquifer is interacting with surface water, thus the hydraulic head contours represent only an average condition. The actual heads and flow directions may vary considerably during the seasons.

Water-table conditions occur over virtually the entire area of the Condie Aquifer. Thus the hydraulic head contours also represent the water-table position and the top of the Aquifer (since the Aquifer comprises only the saturated portion of the Condie Moraine sands and gravels).

The southern flank of the Condie Moraine, consisting of silts, has low permeability and is not considered part of the Condie Aquifer. Instead these silts constitute part of the aquitard overlying a lower aquifer. Water-level and saturation conditions in this silty part of the Condie Moraine are likely to be highly variable, depending on local infiltration and drainage conditions.

5.4 Groundwater Withdrawals and Water Level Changes

The principal user of groundwater from the Condie Aquifer in the period up to 1959 was the Canadian Pacific Railway which pumped water from its shallow well near Pilot Butte (W2-18-17-34) at rates of about 700 dam^3/year (400,000 gallons per day, Hill et al, 1930, p. 82). Presumably withdrawals of groundwater by the Railway have essentially ceased since the advent of diesel engines. The water withdrawn by the Railway appears to have been largely intercepted flow which would otherwise have discharged from nearby springs. No early water level data are available, but it is likely that the Railway's withdrawals had only a local effect on groundwater levels.

Between the years 1904 and 1912 the City of Regina obtained water from infiltration into a 15-inch tile conduit in Range 19, Tp 18, Sections 1 and 2. This conduit led to Boggy Creek Reservoir. The flow, described as copious, supplied water at a rate of about 800 dam^3/year (Hill et al 1930, p. 77). The water evidently came from the Condie Aquifer, which at this point is confined by the Regina Clay. It is not known when the original conduit was abandoned, but in 1912 an 18-inch cast iron line was constructed to carry the water from Boggy Creek well field (Mollard, 1966, Figure 14).

The Inland Cement Company (Genstar since 1982) appears to have pumped water from a well, completed in the Condie Aquifer, since 1958 or 1959 (W2-19-18-03-NW). The average withdrawal rate for the period 1968 to 1980 (Appendix C, Table C-2) was 106 dam^3/year. Water level data are not available. The company is now apparently pumping from a well completed in a lower aquifer, but further data are not available.

City well R2 was completed in the Condie Aquifer in 1960 near the Albert Street Reservoir (W2-20-18-12-NE). Early production data are not available, but for the period 1969 to 1984 the average withdrawal rate was 272 dam^3/year (see Appendix C, Table C-1). Several accurate static water level measurements have been recorded for well R2 and for TH3-IWS59 which was drilled nearby (Appendix B). They are as follows:

November 12, 1959	571.74 m	TH3-IWS59
July 7, 1960	571.47 m	R2
March, 1963	570.74 m	R2
---, 1980	570.56 m	R2

These data suggest that there has been little lowering of groundwater levels in the Condie Aquifer due to pumping from R2.

In addition to the three major users of groundwater from the Condie Aquifer, there are also numerous minor users mostly in the Pilot Butte area. Pumping of water from the gravel pits in the Boggy Creek - Pilot Butte area can also constitute a major groundwater use since many of the gravel pits are essentially large-diameter wells penetrating the top of the aquifer (see for example Associated Engineering Services Ltd, 1977).

Some early data on water levels in the Condie Aquifer have been identified (see Appendix B) in the reports by Wynne-Roberts (1912) and Mackay, Beach and Scott (1936). They are as follows (the data in brackets are the present water levels, estimated from the data shown on Map No. 6):

W2-19-18-02-NE	1935	588 m	(589 m)
W2-19-18-02-SW	1935	589 m	(585 m)
W2-19-18-03	1912	583 m	(582-585 m)
W2-19-18-04	1912	584 m	(578-583 m)

W2-19-18-04-SE	1935	581 m	(582 m)
W2-20-18-09-NW	1935	567 m	(562 m)
W2-10-18-13-SW	1935	565 m	(569 m)

The 1912 and 1935 water levels are about the same as recent levels in the same area. These data and the water level data for well R2 suggest that the water levels in the Condie Aquifer have been relatively steady in this century.

5.5 Hydraulic Properties of the Condie Aquifer

Lissey (1962, p. 76-79) reports detailed data for a pumping test conducted on well R2 (W2-20-18-12-NE) in 1961, with three observation wells. The saturated thickness of the Condie Aquifer at well R2 was 10.7 m. The test yielded a transmissivity of 2.5×10^{-2} m^2/sec, and a specific yield of 0.24. The hydraulic conductivity is 2.3×10^{-3} m/sec. These values of specific yield and hydraulic conductivity are characteristic for a coarse sand.

A pumping test carried out in 1959 on the cement plant well (W2-19-18-03-NW) indicated a similar high transmissivity for the Condie Aquifer (approximately 0.6 m drawdown in the pumping well after 48 hours of pumping at 11.3 L/sec, letter from McPherson and Thorn Limited to Saskatchewan Cement Company, June 17, 1959).

Clifton Associates (1985) report hydraulic conductivities for the sands of the Condie Aquifer, in the area of the Co-op Refinery, ranging from 1.4×10^{-6} m/sec to 8×10^{-5} m/sec, based on piezometer slug tests.

Clearly the transmissivity of the Condie Aquifer can vary widely depending on the saturated thickness and effective grain-size of the sands. The value obtained from the pumping test on well R2 is very high and is probably a near-maximum value for the Condie Aquifer.

5.6 Groundwater Quality in the Condie Aquifer

The natural groundwater quality in the Condie Aquifer is controlled by geochemical processes taking place between water infiltrating into the ground surface and the surficial sediments, and by reactions between water in the aquifer and aquifer sediments. Introduction of contaminants due to industrial, agricultural and municipal activities may cause significant water quality changes. About 50 chemical analyses, not including repeat analyses, have been identified as representing water from the Condie Aquifer (see Table D-1). Map No. 6 shows the sample location, total concentration and water type of selected water quality data from the aquifer. It should be noted that if more than one analysis was available for the same sample location, data from the most recent analysis were used in preparing the map. Figure 2 shows a Piper-plot of the water quality data. It should be noted that this plot of the water quality data is greatly influenced by the uneven distribution of sample locations and by inclusion of water known or suspected to be contaminated.

It is evident from the map, and even more from Table D-1, that a large cluster of sample locations occurs in the central part of the Condie Aquifer. This cluster is the result of recent investigations pertaining to the impact or possible impact of industrial and municipal activities on the groundwater quality in the aquifer (Beckie Hydrogeologists, 1980; City of Regina, 1983; Clifton Associates, 1985). In contrast, there are only a few sample points in the eastern and western parts of the aquifer. The uneven distribution of the water quality data

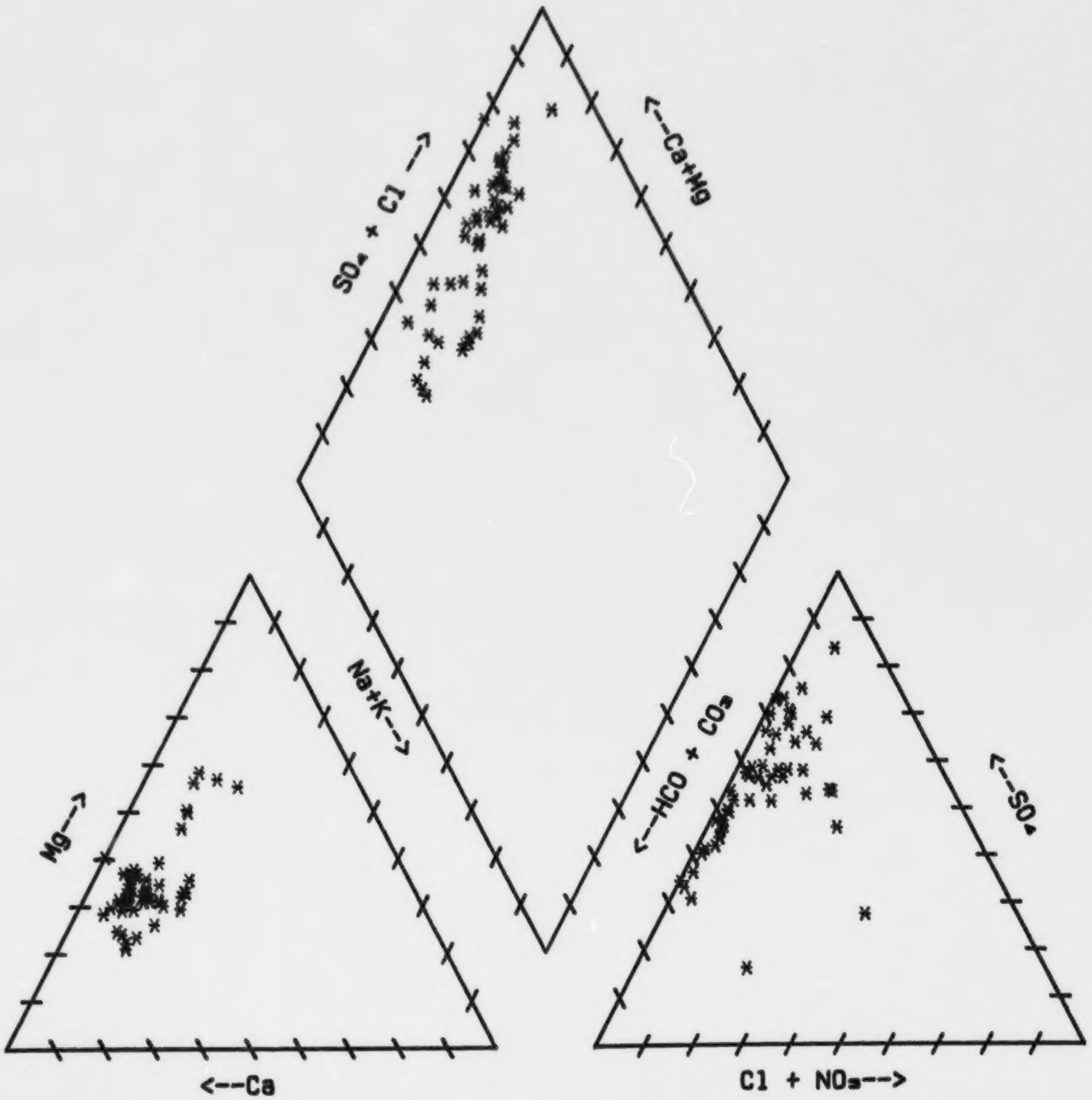


FIGURE 2 PIPER-PLOT OF WATER QUALITY DATA FOR THE CONDIE AQUIFER

only allows for a superficial description of the regional groundwater quality patterns.

In the eastern part the Condie Aquifer forms a surficial aquifer. Consequently, in those areas remote from industrial or agricultural activities, it is expected the aquifer will yield water typical for surficial aquifers in Saskatchewan under similar conditions. Such surficial aquifers generally yield water of the calcium - bicarbonate type with a total concentration of less than 1000 mg/L (e.g. Meneley et al, 1979). Water with such characteristics is encountered in the Pilot Butte area. However, since there are insufficient data points to establish background characteristics, it remains uncertain whether or not the water quality data in the Pilot Butte area truly represent background. The eastern part of the Condie Aquifer is highly susceptible to contamination from industrial and agricultural activities. In this regard the many gravel pits in this area should be mentioned a possible source from which contamination may spread. The high nitrate concentration of 418 mg/L for a sample taken at W2-18-17-23-SE illustrates that, at least locally, contamination due to agricultural activity may occur.

The line separating the areas of the aquifer where aquifer sands outcrop at the ground surface and the aquifer sands are covered by till and clays probably has an important bearing on the water quality in the aquifer. West of this line the natural water quality probably is a mixture of water flowing in from the east and water infiltrating through the clay, till, and silts. In this regard the geochemical processes taking place in the clays and till are probably of importance. However, these processes are still poorly understood and no water quality data are available for the infiltrating water.

Water quality data in the central part of the Aquifer show a large variation in both total concentration and water type without apparent patterns. In addition to the natural processes influencing water quality, infiltration of waste leachates and liquid wastes, at least locally, influenced the water quality (Beckie Hydrogeologists, 1980: Clifton Associates, 1985).

In the western part of the Condie Aquifer only one analysis is available (W2-21-18-26-02-SW). This analysis probably reflects a case of local contamination rather than being representive for the water quality in this part of the aquifer. This is in particular indicated by the high nitrate value of 159 mg/L.

To date, no data are available on the possible natural water quality changes in the Condie Aquifer. The changes in water quality since 1980 in water from the City of Regina's production well R2 (W2-20-18-12-NE) are significant, in particular the increase in the chloride concentration probably is not natural.

5.7 Groundwater Regime of the Condie Aquifer

The data discussed in the previous sections indicate that the Condie Aquifer forms a continuous highly permeable hydrogeological unit with an active groundwater circulation. Presumably, there is a strong interaction with the streams whose beds are hydraulically continuous with the aquifer. Water levels, water quality, and recharge rates in the aquifer may in fact be strongly controlled by this interaction with surface water.

The water levels and hydraulic head contours plotted on Map No. 6 show that the overall gradient has strong east to west component along the axis of the aquifer from about the Pilot Butte area (middle of Range 18) to west of the IPSCO plant site (middle of Range 20). The average value of the east-west gradient is about 2.4×10^{-3}. This gradient, combined with a hydraulic conductivity of the most permeable zone of up to 2×10^{-3} m/sec, implies that groundwater may move by up to 500 metres per year in the aquifer. Similarly the total east to west flow in the eastern half of Range 19 is probably in the range of 1500 to 3000 dam^3/year, (assuming a 1 to 2 km width of the aquifer with a high transmissivity of .02 m^2/sec). This amount of groundwater movement constitutes an important component of the general groundwater balance in the Regina area.

In the Pilot Butte area there is also a marked transverse component of the gradient indicating a flow component from northeast to southwest across the aquifer. In the western part of the aquifer, south of the Condie Reservoir, there appears to be a separate groundwater "high".

The groundwater circulation pattern in the Condie Aquifer can be outlined as follows. In the Pilot Butte area there is strong recharge to the aquifer by infiltration at the ground surface, from gravel pits and from streams. Much of this water probably discharges again relatively nearby to springs and streams. The hydraulic gradient in this area largely reflects the surface topography since the aquifer is essentially a thin cover of sand and gravel draped over a regional slope. As will be discussed in a following chapter, in this area the hydraulic heads in the underlying aquifer zones appear to be slightly lower than in the Condie Aquifer but the degree of interaction between the aquifers is not known.

Further to the west, approximately in Ranges 19, 20 and 21 the character of the flow regime changes. Recharge is largely by east-to-west flow originating in the Pilot Butte - Boggy Creek Reservoir area. There is also recharge by infiltration from the ground surface, but the component is probably relatively small due to the presence of a surface cover of Regina Lake clay and Battleford till. Surface infiltration may be relatively strong in two smaller areas; the intermittent sloughs in W2-19-18-2 north of the Correctional Institute and the gravel pits at the topographic high north and west of Condie. In addition there may be a recharge or discharge component from Boggy Creek at various points between Condie and Boggy Creek Reservoirs. The degree of hydraulic connection between the Condie Aquifer and Boggy Creek in the area is not known at present.

Discharge from the western part of the aquifer is almost entirely by downward flow through the underlying glacial till to the aquifer below. This flow will be further discussed in a following chapter. There is probably a minor discharge component to Wascana Creek in Range 21, Township 18 where the creek valley cuts through the aquifer.

The limited data on withdrawals and change of water levels suggest that withdrawals have had little effect on water levels. This result is consistent with the picture of the Condie Aquifer as a highly permeable aquifer with strong through-flow. The withdrawals from the western half of the aquifer, averaging about 400 dam^3/year since 1959, constitute only a small fraction of the total through-flow, estimated at 1500 to 3000 dam^3/year.

As will be discussed in a following chapter, the hydraulic head in the underlying aquifer appears to have decreased by about 5 metres since the start of groundwater withdrawals. Most of the discharge from the western part of the Condie Aquifer is now downward to the underlying aquifer, but it would appear that before groundwater withdrawals started, the downward flow to the underlying aquifer would have been less and more of the discharge would have gone directly to Boggy Creek and Wascana Creek. It follows that water levels in the western part of the Condie Aquifer should have been somewhat higher in the first decades of this century than at present. However, the very limited early water-level data that have been identified do not indicate much higher levels (see Section 5.4).

At present there are no continuous water-level records available for the Condie Aquifer. The magnitude of seasonal fluctuations is therefore unknown. Judging from water-level records obtained from the Saskatchewan Research Council's observation well network, seasonal fluctuations are probably less than 0.50 metres, in most of the Aquifer. At points where the groundwater interacts with surface water larger fluctuations may occur.

The water quality data (see Map No. 6) are roughly consistent with the foregoing interpretation of the groundwater regime. Total concentration values are generally low in the Pilot Butte area, where most of the recharge occurs. Further west the values are higher and more erratic as are water types. These water quality data presumably reflect water of mixed origin. Infiltration of waste leachates and liquid wastes probably also has influenced the water quality.

6. GROUNDWATER RESOURCES OF THE UPPER FLORAL FORMATION SANDS AND GRAVELS AND INTERGLACIAL SEDIMENTS

6.1 Extent and Thickness of the Upper Floral Sands and Gravels

The extent, depth to and thickness of the Upper Floral Formation Sands and Gravels are shown on Map No. 2. The extent virtually coincides with that presented by Christiansen (1979a, drawing 0016-003-21). However, in Range 20, Township 18, some testhole data have been reinterpreted, resulting in an extension of the Upper Floral Sands and Gravels in this area.

It should be noted that the extent shown on Map No. 2 does not necessarily imply continuity of the sands and gravels within that area. In this regard the additional cross sections presently under preparation for a follow-up report may provide further information.

The depth at which the Upper Floral Formation Sands and Gravels occur below ground surface may range from less than 5 metres in the Mound Springs well field area to a typical range of 20 to 40 metres in the vicinity of the City of Regina. The thickness of the Upper Floral Sands and Gravels may typically range from 10 to 30 metres.

6.2 Extent and Thickness of the Interglacial Sediments

The extent, depth to and thickness of the Interglacial Sediments is shown on Map No. 4. As was previously mentioned (see Section 3.3.3), the extent is limited to the collapse structure beneath the City of Regina.

The depth below ground surface at which the Interglacial Sediments occur may range from 8 to 60 metres, and its thickness ranges from 25 to

112 metres. In Range 20, Township 18, a testhole suggests the presence of Interglacial Sediments in Sections 15 and 16. Insufficient geological data are available to determine whether or not the occurrence in this area is related to a local collapse structure or part of the Regina collapse.

In the context of definition of aquifer zones it is important to note on cross sections C'-C" and J'-J" (see Appendix A) that the Upper Floral Sands and Gravels are in direct contact with the Interglacial Sediments.

6.3 Definition of Aquifers

From a hydrogeological point of view of both the sands and gravels of the Upper Floral Formation and the sands and gravels included in the Interglacial Sediments form aquifer zones.

While the term Upper Floral Formation Sands and Gravels was not introduced until 1979 (Christiansen, 1979a), Lissey (1962) refers to the aquifer formed by these sediments as the Regina B-Zone Aquifer and Avonhurst Aquifer, respectively. It is of particular interest to note that Lissey (1962, Figures 33 and 39) implies, but does not elaborate on, the existence of a "gap" between the Regina B-Zone Aquifer and the Avonhurst Aquifer. This "gap" occurs in the eastern half of Range 19, Townships 17 and 18. The present study points to the existence of a hydraulic discontinuity in this area (see Map No. 7). Water level data in the Interglacial Sediments indicates hydraulic continuity between the aquifer zones formed by the Upper Floral Sands and Gravels and the Interglacial Sediments. Consequently, in this report the term "Regina Aquifer" is introduced. The "Regina Aquifer" is defined as the aquifer formed by the Upper Floral Sands and Gravels and the Interglacial Sediments, west of the hydraulic discontinuity shown on Map No. 7. The name is put between quotation marks to indicate uncertainty in the exact location and nature of the discontinuity.

East of the "gap" or hydraulic discontinuity, Lissey (1962) lumped the Condie Aquifer and Upper Floral Sands and Gravel together into one aquifer: the Avonhurst Aquifer. However, since the Condie Aquifer is properly defined (see Section 5.2), the term Avonhurst Aquifer should be abandoned. In the areas north and east of the Boggy Creek and Mallory Springs well fields the geological and hydrogeological setting is insufficiently defined at the present time to justify assigning aquifer names. The same is true for the Mound Springs well field area. Consequently, in these areas the aquifer zones formed by Upper Floral Sands and Gravels are simply referred to as aquifer zones of the Upper Floral Formation.

Throughout the study area pockets of Upper Floral Sands and Gravels occur which form local aquifer zones. These aquifer zones also remain unnamed.

6.4 Water Levels

Well water-level data from 1900 to the present are presented in detail in Appendix B. The data for the period 1970-1985 are plotted on Map No. 7, including both surveyed and estimated levels. The surveyed data shown on the map are all for period 1980-1985 and thus represent the present-day hydraulic head distribution relatively accurately.

The most important feature of the hydraulic head distribution shown on Map No. 7 is the apparent hydraulic discontinuity, marked on the map, on the east side of Range 19 in Townships 17 and 18. This hydraulic discontinuity is evidenced by a 20 to 30 metre difference in hydraulic head over a distance of 4 to 5 km, corresponding to a gradient of about 5×10^{-3}. To the west of this discontinuity the piezometric surface is practically flat with a gradient of less than 5×10^{-4}. To the east the hydraulic heads rise gradually, by about 30 m in 10 km, a gradient of about 3×10^{-3}. This contrast of hydraulic gradients implies a large contrast of transmissivity or flow, most likely a greatly reduced transmissivity in the zone of discontinuity. This discontinuity is therefore tentatively taken as the separation between the "Regina Aquifer" and the aquifer zones of the Upper Floral Formation further east and north.

The piezometric surface in the "Regina Aquifer" is virtually flat, varying in height by only one or two metres. These minor variations, as shown on Map No. 7 mostly reflect localized drawdown "cones" around production wells (see for instance the drawdowns of about 1.5 metres around the Co-op Refinery wells, as documented by Clifton Associates, 1985). Hydraulic heads in the Interglacial Sediments appear to be continuous with the heads in the Upper Floral Sands and Gravels.

Continuous water level records are available for the period 1978 to 1985 from the Saskatchewan Research Council's observation well (W2-20-18-15-12-NW) completed in the "Regina Aquifer" to the northwest of the City. These records show irregular seasonal variations of the water level of up to 1 metre (see Figure 3). The water level is probably influenced by pumping from City of Regina wells W1, W2, W3, W4 and W5, south of the observation well.

Water level data for the Upper Floral Formation aquifer zones are sparse for the area east and north of the hydraulic discontinuity. In

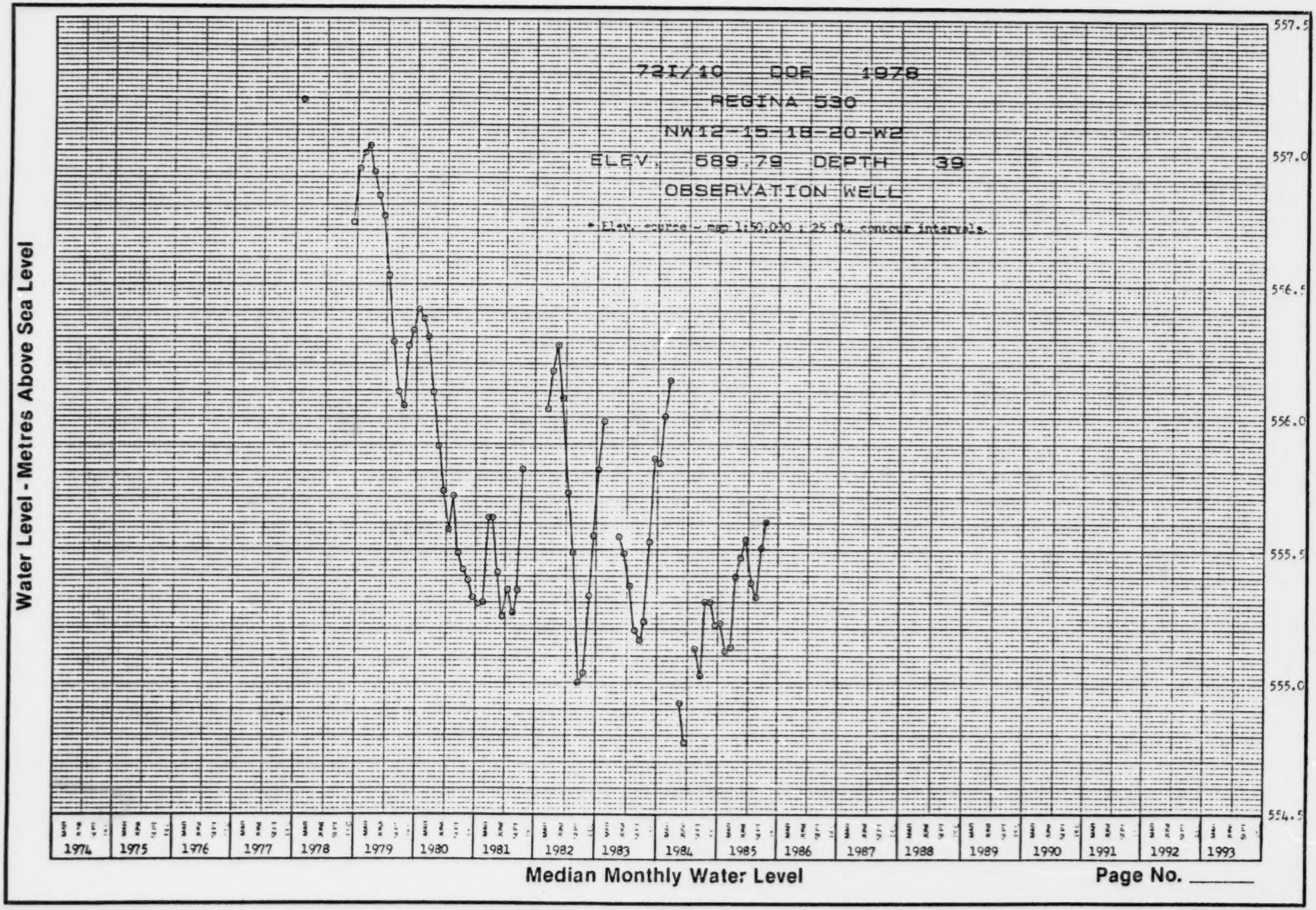


Figure 3. Water-level records for Saskatchewan Research Council Observation Well Regina 530

the area north-east of Balgonie the data indicate a piezometric "high" which appears to be due to infiltration from Boggy Creek in the reach between 625 m and 648 m stream-bed elevations (Ranges 17 and 18, Township 18). Water level "mounding" due to recharge from Boggy Creek in this area has been described in more detail by Mollard (1975).

South-east of Regina (Range 19, Townships 16 and 17) there is an area where the hydraulic heads are near or above ground surface, implying a hydraulic connection with aquifer zones to the northeast.

The relation of groundwater levels to surface water elevations should also be noted. The present-day hydraulic head in the "Regina Aquifer" is lower than Wascana Creek, except perhaps in the very western part of the aquifer (Range 21, Township 21). The static water levels in the Boggy Creek and Mallory Springs well fields are approximately equal to the elevations of the streams in the well-field areas. Further north, in Range 20, Township 19, groundwater in the Upper Floral sands and gravels presumably discharge to the tributaries of Flying Creek, but no groundwater data are available to verify this assumption.

In the "Regina Aquifer" free water-table conditions occur in a small area centered on W2-19-18-05, the Co-op Refinery area. In several other parts of the aquifer the hydraulic head is only 1 or 2 metres above the top of the aquifer. Water-table conditions therefore probably occur in isolated spots throughout much of the aquifer and the total area with water-table conditions will increase rapidly if the hydraulic head in the aquifer decreases.

East of Boggy Creek well field the aquifer zones of the Upper Floral Formation are under water-table conditions in an area centered on W2-17-18-07. In this area the Boggy Creek valley cuts into the top of the Upper Floral Sands and Gravels and water table "mounding" near the creek has been observed (Mollard, 1975).

6.5 Groundwater Withdrawals and Water-Level Changes

Groundwater has been withdrawn from the "Regina Aquifer" at steadily increasing rates since about the year 1900. Estimated withdrawals, based on the data presented in Appendix C are shown in Figure 4, averaged over 10-year intervals. Prior to 1969 only a few rough estimates of withdrawals are available and hence there is considerable uncertainty as to the actual withdrawals. There is little doubt however that the overall increase of withdrawals as shown in Figure 4 is roughly correct.

Also shown in Figure 4 are the averages of all static water levels recorded for the "Regina Aquifer", as listed in Appendix B, also averaged over 10-year intervals. Together with these averaged data, individual reliable (surveyed) data for the Imperial Oil Refinery wells and the Co-op Refinery are also plotted. The standard deviations and the maximum and minimum levels are also shown. The very early data, for 1910, are taken from the report by Wynne-Roberts (1912). The large spread in these data are a reflection of the inaccuracies inherent in these early data, which are reported as the height to which water rose above the bottom of the well.

The water-level data clearly show a drop in static water-levels of about 5 to 6 metres between 1940 and 1980. The accurate data from the oil refinery sites follow the general trend, with small deviations due to localized drawdowns around the refinery pumping wells. It is likely that some water-level decline occurred prior to the 1945-1955 decade,

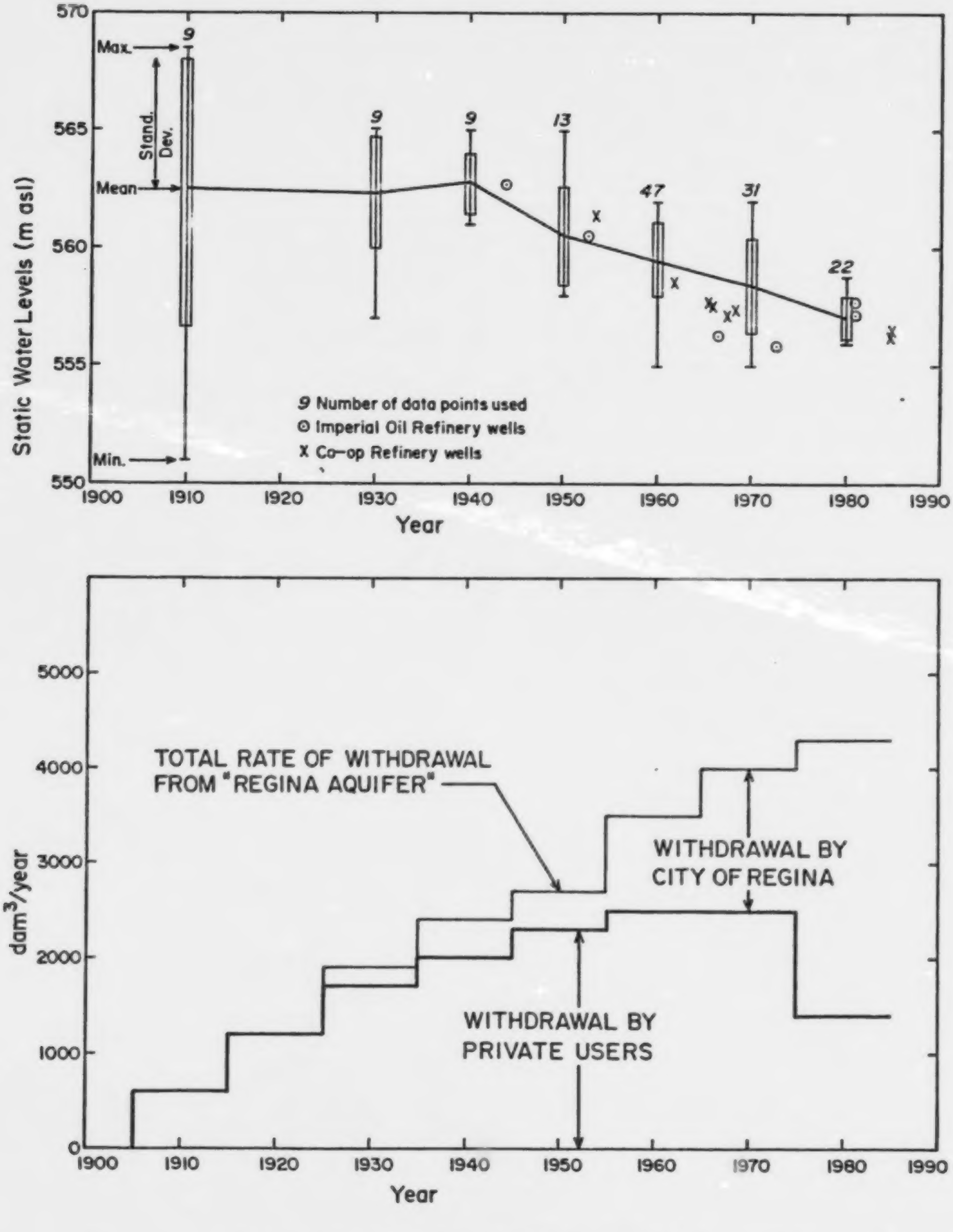


Figure 4. Averaged water levels and estimated average withdrawals for the "Regina Aquifer", 1905-1985

since there were significant withdrawals prior to 1945. The early water-level data are unreliable and do not exclude this possibility.

The relatively small spread of the data points for each 10-year interval from 1930 onward show that the "flatness" of the piezometric surface has been maintained through the years. In other words, the static water levels have declined at a roughly equal rate throughout the aquifer. This general pattern gives a strong indication that the "Regina Aquifer", as defined in this report, is indeed hydraulically continuous throughout.

East of the discontinuity which marks the eastern edge of the "Regina Aquifer", Boggy Creek and Mallory Springs well fields have been withdrawing groundwater since 1908 at rates of 4000 to 5000 dam^3/year. Withdrawals by other groundwater users in the area are minor compared to these rates. During the period 1969 to 1984, the average withdrawal rate from Boggy Creek and Mallory Springs well fields were 4065 dam^3 and 298 dam^3/year respectively (Appendix C).

Static water levels for the well fields, listed in Appendix B are erratic, but give no indication of long-term declines. Selected data from Appendix B are as follows:

Boggy Creek Wells:

K3	1929	586.44 m
191	1944	593.69
191	1959	above 594.09 (flowing)
P60	1960	597.96
TH1-H61	1961	585.98
BC-4	1976	590.25
BC-5	1977	595.64

BC-6A	1982	596.24
BC-4	1985	above 594.09 (flowing)
Mallory Springs:		
K1	1929	582.46
K1	1929	580.93
K1	1967	580.22
K1	1985	above 585.20 (flowing)

The up-and-down nature of these static water levels reflects the variations of pumping rates and of natural recharge rates. No reliable or repeated water-level measurements are available for the recharge areas of the aquifer zones supplying these well fields. If there has been any long-term decline of water levels in these aquifer zones it has probably been no more than a few metres, but there are no data available to document such a decline.

6.6 Hydraulic Properties

Pumping tests for the Upper Floral Sands and Gravels and the Interglacial Sediments have been described in various reports. The transmissivities obtained from these tests are summarized in Table 1. Storage coefficients have not been tabulated since these are generally unreliable.

The Upper Floral Sands and Gravels of the "Regina Aquifer" mostly have high transmissivities, averaging 1.2×10^{-2} m^2/sec (1040 m^2/day). The Interglacial Sediments appear to have lower transmissivities, averaging 3.3×10^{-4} m^2/sec (72 m^2/day).

In the Boggy Creek well field the average transmissivity is 4.2×10^{-3} m^2/sec (360 m^2/day). Mallory Springs yielded a higher value of 1.6

TABLE 1 TRANSMISSIVITIES OF THE UPPER FLORAL SANDS AND GRAVELS AND INTERGLACIAL SEDIMENTS

AREA	LOCATION	WELL NO	SOURCE OF DATA	TRANSMISSIVITY (M2/SEC)
REGINA AQUIFER (1)	W2-19-18-03-SE	TH2-BR60	LISSEY 62	4.4E-3
REGINA AQUIFER (1)	W2-20-17-27-NW	TH4-H61	LISSEY 62	1.6E-2
REGINA AQUIFER (1)	W2-20-17-32-15-NW	W4	JACKSON 64	1.6E-2
REGINA AQUIFER (1)	W2-20-17-35-15-NW	W2	JACKSON 64	1.8E-2
REGINA AQUIFER (1)	W2-20-17-33-16-NE	W1	JACKSON 64	1.3E-2
REGINA AQUIFER (1)	W2-20-17-34-NW	TH4-H6	LISSEY 62	1.6E-2
REGINA AQUIFER (1)	W2-20-18-06-SE	TH11-BR61	LISSEY 62	1.1E-2
REGINA AQUIFER (1)	W2-20-18-08-NE	TH96-BR60	LISSEY 62	1.7E-3
REGINA AQUIFER (1)	W2-21-16-25-NE	SPC WELL	MOLLARD 65	1.3E-2
REGINA AQUIFER (2)	W2-20-17-22-NE	RCMP PW3-73	MOLLARD 73	1.3E-3
REGINA AQUIFER (2)	W2-20-17-24-NW	TH1-P61	LISSEY 62	9.4E-4
REGINA AQUIFER (2)	W2-20-17-26-NE	TH8-BR60	LISSEY 62	2.4E-4
BOGGY CREEK WELLS	W2-18-18-07-NE	BC6A	MLM82	4.3E-3
BOGGY CREEK WELLS	W2-18-18-07-NE	P60	LISSEY 62	4.4E-3
BOGGY CREEK WELLS	W2-19-18-12-NW	TH1-H61	LISSEY 62	4.7E-3
BOGGY CREEK WELLS	W2-19-18-12-NE	2A-H61	LISSEY 62	3.5E-3
MALLORY SPRINGS	W2-19-17-25-NW	P1-H67	MOLLARD 67B	1.6E-2
BALGONIE AREA	W2-17-18-04-NE	WELL #2	SASK ENV. 70	2.4E-3
BALGONIE AREA	W2-17-18-07-NE	PW1-75	MOLLARD 75	4.8E-3
BALGONIE AREA	W2-18-17-29-13	OBS 85-1	BECKIE 85	3.0E-4
BALGONIE AREA	W2-18-17-35-04-NW	#2 TRIAL WELL	BECKIE 77	2.4E-4
BALGONIE AREA	W2-18-18-10-16-NE	#3 TRIAL WELL	BECKIE 77	7.8E-4

NOTES (1) UPPER FLORAL SANDS AND GRAVELS
(2) INTERGLACIAL SEDIMENTS

x 10^{-2} (1380 m^2/day). Transmissivities in the area northeast of Balgonie average 1.7 x 10^{-3} (150 m^2/day).

6.7 Groundwater Quality

Based on the present knowledge, chemical analyses representing groundwater in the aquifer zones of the Upper Floral Formation and Interglacial Sediments have been identified and are marked in Table D-1 (Appendix D). On Map No. 7, the sum of ions and water type has been indicated for the sample locations. Again, if more than one analysis was available for the same sample location, only the most recent analysis was used. It should be noted that no water quality data are available north of Township 18. A Piper-plot of the water quality data is shown in Figure 5.

It is evident from Figure 5 and Map No. 7 that at large, both in terms of total concentration and water type, there are no major differences in water quality between the "Regina Aquifer" and the Upper Floral aquifer zones east of the hydraulic discontinuity.

Groundwater in the "Regina Aquifer" ranges in total concentration from 550 to 1550 mg/L, but typically is in the 1000 to 1500 mg/L range. Of interest are the water quality data along the northern portion of the aquifer in Range 20, Township 18 since the total concentration in this area is less than 1000 mg/L. The water quality data of a well at W2-20-18-13-06-SE plot outside the area representative for water quality data in Upper Floral aquifer zones (see Figure 5). This well yields water with a total concentration of 786 mg/L, but both in an absolute and relative sense has a low sodium concentration. The well is located in a

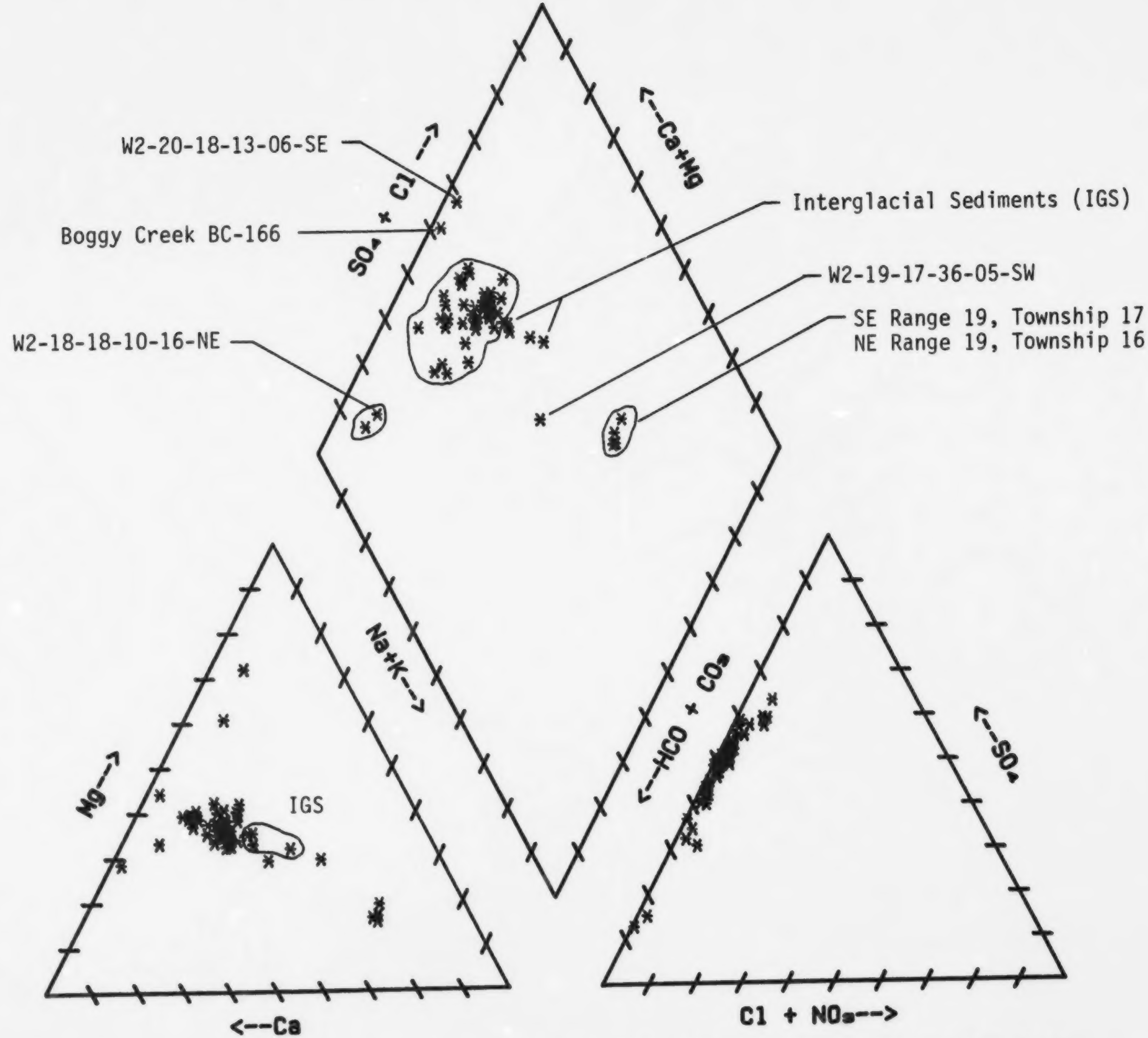


FIGURE 5 PIPER-PLOT OF WATER QUALITY DATA FOR UPPER FLORAL FORMATION SAND AND GRAVEL AQUIFER ZONES AND INTERGLACIAL SEDIMENTS

geologically complex area, and may have been completed in an isolated aquifer zone.

In terms of water type, groundwater in the "Regina Aquifer" is of the Ca/Mg - SO_4, Ca/Mg - HCO_3, and Ca - SO_4 type. The distribution of the water types is erratic and at present insufficient data area available to distinguish any major regional patterns. It is evident from Figure 5 that the water type is determined by the relative concentrations of sulphate and bicarbonate and that the relative cation concentrations plots within a narrow field. Compared to water in the Condie Aquifer (see Figure 2), which recharges the "Regina Aquifer", water in the "Regina Aquifer" appears to have a slightly higher relative concentration of sodium and potassium. This possibly may be due to cation exchange in the aquitard separating these aquifers.

Water in the Interglacial Sediments ranges in total concentration between 1440 and 1770 mg/L. However, only a limited number of samples are available. Groundwater in this aquifer zone is characterized by a slightly higher relative concentration of sodium and potassium compared to water in the overlying "Regina Aquifer" (see Figure 5).

For all the City of Regina production wells completed in the "Regina Aquifer", the R and W wells, repeat analyses are available since 1980 (see Maathuis and Van der Kamp, 1985). Exceptions are well R2 which is completed in the Condie Aquifer and well W5 for which no analyses are available. For the W wells a 1966 analysis is also available (Mollard, 1966).

No information is available on the consistency of sampling procedures, sampling points, and sample preservation and handling. Taking this into account, the repeat analyses show that no major water quality changes appear to have taken place since 1966.

East of the hydraulic discontinuity the water quality data show a more definite pattern. At W2-18-18-10-16-NE (see Figure 5 and Map No. 7), the Upper Floral aquifer zone yields water with a total concentration of less than 500 mg/L and is of the Mg - HCO_3 type. This water is derived from Boggy Creek which in this area loses water through its bed into the aquifer. From this recharge area towards the Boggy Creek and Mallory Springs well fields both the total concentration and water type changes. Towards Mallory Springs, along the southern fringe of the aquifer zone, the total concentration increase to values of 700 mg/L just east of Mallory Springs and to 900 mg/L at the well field. Water in this area is of the Ca/Mg - HCO_3 type. Just north of Mallory Springs, at W2-18-17-30-12-SW, the aquifer zone yields water which is more mineralized and is of the Ca - SO_4 type (see Figure 5 and Map No. 7). Both the depth to the aquifer zone and the water level at this location (see Map No. 2) suggest that the aquifer zone in this area may be isolated.

The Boggy Creek well field area is located in an area where the geological setting is not yet fully understood. Production wells in the well field area have been completed at different depths in the aquifer zone and the large variation in both total concentrations and water types reflects the complexity of the area. The water quality data for all but one of the Boggy Creek production wells plot on the Piper-plot within the main cluster representing groundwater in the Upper Floral Formation aquifer zones. However, the water quality data from production well BC-166 plot outside these clusters due to a low relative sodium concentration. This well, completed at a depth of about 14 metres, also yields the freshest water (total concentration 840 mg/L).

For the individual production wells in both the Boggy Creek and Mallory Springs well fields water quality data are available dating back to 1966 (Table D-1 or Maathuis and Van der Kamp, 1985). These data indicate that no major changes in water quality have taken place since 1966.

An unnamed Upper Floral aquifer zone in the southeastern part of Range 19, Township 16 and northwestern part of Range 19, Township 15, yields water which both in term of concentration and water type differs significantly from groundwater elsewhere in Upper Floral Formation aquifer zones. In particular, it is characterized by significantly higher sodium concentrations (see Figure 5).

6.8 Groundwater Regime

6.8.1 The "Hydraulic Discontinuity" in Range 19

The apparent hydraulic discontinuity in Range 19, Townships 17 and 18, as marked on Map No. 7, is an important factor in a description of the flow pattern in the Upper Floral Formation Sands and Gravels. Direct geological evidence for a discontinuity is lacking and would require detailed test drilling, but the water-level data leaves little room for doubt that a marked hydraulic discontinuity must exist.

The most plausible interpretation of the water-level data is a lack of continuity of the Upper Floral Formation aquifer zones. This lack of continuity leads in effect to a greatly reduced transmissivity, a much reduced flow and a high hydraulic gradient. The discontinuity forces groundwater flow coming from the east to the surface thus giving rise to Mallory Springs and the springs in the Boggy Creek area. If the aquifer zones were continuous (see for instance cross-section C -C", Appendix A) then there is no apparent reason why these springs should occur where they do, and in fact Boggy Creek would probably be less "Boggy". In the years prior to substantial groundwater withdrawals the strong flow coming from the east would then have lead to high hydraulic heads and possibly flowing wells in the city area, and to large springs where the "Regina Aquifer" extends under Wascana Creek. As will be discussed more fully in a following section, it is unlikely that such springs ever existed, nor is there any record of near-surface groundwater levels.

The nature, exact location, and degree of discontinuity can only be established by further test drilling, water-level measurements and pump testing in the critical area. In the meanwhile the "Regina Aquifer" will be considered as a separate hydraulic entity, making an allowance for some flow through the "discontinuity".

6.8.2 Groundwater Regime of the "Regina Aquifer"

The water-level data (see Section 6.4) show that the piezometric surface of the "Regina Aquifer" is relatively "flat" for the period 1980 - 1985 and has always been flat even though the average hydraulic head has decreased by 5 to 6 metres since about 1940. This flatness implies considerable hydraulic continuity throughout the aquifer, despite the relative vertical displacements of the aquifer zones as encountered in different test holes.

The decline of static water level means that individual well yields have also decreased correspondingly, due to the smaller available drawdown. Depending on the depth of the wells, the decrease of yield could be anywhere from 10 to 50 percent.

The high transmissivity of about 10^{-2} m^2/sec (see Section 6.6) together with the continuity and thickness of the overlying aquitard mean that drawdown "cones" around pumping wells will be shallow and very flat, extending out to distances of 10 kilometres and more. It is this property of the aquifer-aquitard system which causes the flatness of the piezometric surface in the aquifer. The large extent of the drawdown cones also means that all the production wells in the "Regina Aquifer" should be considered as mutually interfering to various degrees. Close spacing of production wells may be useful for back-up in case of pump failure, but will not materially increase the total possible withdrawal from the aquifer.

The hydraulic head data for the "Regina Aquifer", as plotted on Map No. 7, do not allow meaningful head contours, or flow directions to be drawn. There is a suggestion of higher heads in the east and north, implying flow towards the pumping centre from these sides. The head in the aquifer is almost everywhere below the bottom of Wascana Creek, so that discharge from the aquifer to the creek is practically excluded, but there may be some recharge from the creek.

The hydraulic head in the "Regina Aquifer" has declined steadily since about 1940 (see Figure 5) by about 0.15 metres per year, a total drop of 5 to 6 metres. This decline of water level can only be due to an excess of discharge over recharge during the past 40 years and clearly has an important bearing on future management of the groundwater resources of the aquifer. The various components of the water balance for the aquifer must therefore be carefully evaluated, bearing in mind its interaction with the overlying Condie Aquifer.

Water balance estimates for the western part of the Condie Aquifer and for the "Regina Aquifer" are summarized in Tables 2 and 3. The western part of the Condie Aquifer is taken to be that part of the Condie Aquifer which overlies the "Regina Aquifer", i.e. the part west of the "hydraulic discontinuity" in the Upper Floral Formation sands and gravels (Range 17, Townships 17 and 18). It turns out that the water balance estimates for the decade around 1980 can be much improved if the state of affairs prior to groundwater pumping, say in the year 1900, is also considered. Thus Tables 2 and 3 include estimates for both 1900 and 1980.

Consider the groundwater conditions in 1900. At that time the western part of the Condie Aquifer was receiving an estimated 1500 to 3000 dam^3 per year by the lateral flow from the east, plus additional recharge by vertical infiltration. This flow must have discharged to Boggy Creek, Wascana Creek or the "Regina Aquifer" below. The "Regina Aquifer" received recharge from the Condie Aquifer above, by lateral flow through the "hydraulic discontinuity" in Range 19 and by vertical infiltration. All the recharge to the "Regina Aquifer" could only be discharged to springs and seeps in the valley of Wascana Creek where its elevation lies below 565 metres, i.e. between W2-20-17-32 and W2-21-18-10. (This analysis assumes that in 1900 the head in the "Regina Aquifer" lay between 560 and 565 m and that in the Condie Aquifer it may have been 0 - 5 metres higher than at present.)

Now there is no record of large springs on Wascana Creek in the area of the "Regina Aquifer"; certainly not of springs with flows equi-

COMPONENT OF WATER BALANCE	VOLUME OF WATER PER YEAR (DAM^3) 1900	1980
RECHARGE		
- lateral flow from east	1500-3000	1500-3000
- infiltration from ground	500-1500	500-1500
- from surface impoundments	0	10- 100
- from Boggy Creek	0	0- 500
DISCHARGE		
- to Boggy Creek	1000-3500	0- 500
- to Wascana Creek	100- 500	100- 200
- to "Regina Aquifer"	100- 500	1500-3000
- to withdrawals	0	400
NET CHANGE IN STORAGE	0	0-3000

Table 2. Water balance estimates for the western part of the Condie Aquifer

COMPONENT OF WATER BALANCE	VOLUME OF WATER PER YEAR (DAM^3) 1900	1980
RECHARGE		
- lateral flow from east	100- 500	100- 500
- from Condie Aquifer	100- 500	1500-3000
- infiltration from ground	100- 500	100-1000
- from Wascana Creek	0- 100	0- 100
- from surface impoundments	0	0- 100
DISCHARGE		
- to Wascana Creek	300-1000	0- 100
- to withdrawals	0	4300
NET CHANGE IN STORAGE	0	300-1000

Table 3. Water balance estimates for the "Regina Aquifer"

valent to the present withdrawals of about 4000 dam^3 per year (130 litres per second). Mackay, Beach and Scott (1936, p. 11) say of Wascana Creek: "The flow of the creek is not large and ceases in the summer"; this at a time when the head in the aquifer was still at about 602 metres (see figure 4), well above the creek bed in the west. Large springs, say with a flow of more than 1000 dam^3/year (40 litres per second) would certainly have been noticed, and very likely developed as a water source. The total discharge from the "Regina Aquifer" in 1900 is therefore put at less than 1000 dam^3 per year. This value in turn puts a strong limit on the components of recharge. In particular, lateral flow from the east through the "hydraulic discontinuity" must have been less than 1000 dam^3/year, and probably no greater than 500 dam^3 per year. The estimated water balance of the "Regina Aquifer" in 1900 is shown in Table 3.

The next problem concerns where the large discharge from the Condie Aquifer, at least 1500 dam^3 per year, occurred in 1900. Discharge of this magnitude to Wascana Creek is excluded as argued above, and so is flow of this magnitude to the "Regina Aquifer". The main discharge must therefore have been to Boggy Creek. Mackay, Beach and Scott (1936, p.11) mention that in Ranges 19 and 20 "The creek is fed by springs and except in very dry reasons flows continuously". The existence of Condie Reservoir provides an important clue. This reservoir was constructed by the Canadian National Railway in the late 1920's to provide water for its Regina area operations. Retired CNR employees indicate that about 1000 dam^3 per year were pumped from the Reservoir to the Regina CNR yard. The Reservoir apparently always had sufficient water and there is a suggestion that the Reservoir was fed in part by springs on its south side. In view of the probable hydraulic connection of the Condie Aquifer to Condie Reservoir it seems reasonable to hypothesize that in 1900 much of the discharge from the Condie Aquifer took place to Boggy Creek in the Condie Reservoir area. A substantial proportion of the discharge probably also occurred further upstream in Township 18, Range 19 where the creek valley was very boggy, as attested by inspection of old aerial photographs. The 1900 water balance estimates for the Condie Aquifer are summarized in Table 2.

By 1980 the situation had changed considerably. Recharge to the western part of the Condie Aquifer is probably still much the same as in 1900, except that the water-level data now indicate some inflow at the Condie Reservoir area rather than outflow (see Map No. 6). Discharge from the Condie Aquifer is now largely to the "Regina Aquifer". In other words, the decline in piezometric head in the "Regina Aquifer" has apparently been large enough to divert all the flow which used to discharge to Boggy Creek in the Condie Reservoir area. This flow now goes mostly to supply withdrawals from the "Regina Aquifer". It is not known by how much the water-table in the Condie Aquifer has declined, but given a specific yield of about 0.25 (see Section 6.5) and an area of about 100 km^2, an average decline of 1 metre would yield 25000 dam^3. The volumes of water being withdrawn from storage in the Condie Aquifer may therefore be very large and are estimated at anywhere from 0 to 3000 dam^3 per year (see Table 2).

In 1980 practically all discharge from the "Regina Aquifer" was by withdrawals, averaging 4300 dam^3 per year. Much of these withdrawals are balanced by inflow from the Condie Aquifer and by water withdrawn from storage. This latter quantity is difficult to estimate because it depends very much on how much of the aquifer is under water-table conditions. The rate of infiltration from the ground has no doubt been much influenced by urbanization, involving leakage from water mains and sewer pipes, lawn watering, removal of vegetation, paving etc.

Estimates for the 1980 water balances are given in Tables 2 and 3. Clearly, a wide range of uncertainty remains for many of the components. It is likely however, that the present rate of withdrawal from the "Regina Aquifer" exceeds the long-term sustainable yield of the "Regina" - Condie Aquifer system and aquifer reserves are probably being slowly depleted.

It is worthwhile to consider for a moment what might happen if withdrawals from the "Regina Aquifer would cease. The groundwater levels would then rise until minor discharge to Wascana Creek and major discharge to Boggy Creek would be restored. Such a rise in hydraulic head and an accompanying rise of the water table above, could lead to problems such as flooding basements, ground instability and the reappearance of contaminants such as gasoline which tend to "float" on the water table. Such problems might in fact be negligible, but should be considered if pumping were ever to stop. In effect the "Regina Aquifer" functions as a deeply buried drain under the city area, pumped out by the production wells.

The interaction of the "Regina Aquifer" with the Condie Aquifer also raises important management questions with respect to possible contaminant movements. The thickness of the till separating the two is shown on Map No. 3. The till has been encountered in all the drilled holes, but with thickness varying from 2.7 to 26.2 metres. The head difference across the till ranges from about 5 metres in the west to over 20 metres in the east. Downward hydraulic gradients are as high as 2.0 or 3.0 for the thinner parts of the till. Such gradients could lead to downward flow velocities of up to a metre or more per year, depending on the vertical hydraulic conductivity of the till. It is interesting to note that estimated total vertical flow to the "Regina Aquifer" from the Condie Aquifer, 1500 to 3000 dam^3/year, gives an average downward flow rate of about 1.5 to 3.0 cm per year (assuming an area of about 100 km^2), and an average downward velocity of 6 to 12 cm per year, assuming an effective porosity of 0.25. The flow rates in the thinnest parts of the till must be considerably higher than these averaged values. Thus water from the Condie Aquifer may require only a few years to reach the "Regina Aquifer". Leaking well casings, unplugged test holes, or possible "gaps" in the till would of course constitute even faster pathways for water movement. It is clear therefore that the till separating the two aquifers cannot be relied upon as a long-term barrier preventing contaminants in the Condie Aquifer from reaching the "Regina Aquifer".

6.8.3 Groundwater Regime of the Upper Floral Formation Sands and Gravels East and North of the "Hydraulic Discontinuity"

In the proceeding section the regime of the "Regina Aquifer" has been analyzed at length. It should be born in mind however that Boggy Creek and Mallory Springs well fields have been supplying water at rates of 4000 to 5000 dam^3 per year for half a century without indication of serious water-level declines. The potential sustained yield of these well fields and the aquifer zones supplying them therefore exceeds that of the "Regina Aquifer".

Three principal recharge sources can be identified for the Boggy Creek and Mallory Springs well fields. These are:

(a) Recharge by direct water movement from the bed of Boggy Creek to the Upper Floral Formation aquifer zones between W2-18-18-10 and W2-17-18-17, as evidenced by groundwater "mounding" near the creek.

(b) Recharge through overlying tills in the area northeast of Boggy Creek well field, a process similar to that which supplies 2000 dam^3 per year to Mound Springs well field (see Section 7.7).

(c) Downward flow from the Condie Aquifer where it overlies the Upper Floral Formation aquifer zones in the area east of the well fields.

Due to the sparsity of data the relative importance of these three recharge sources cannot be reliably estimated. The water quality data for Mallory Springs well field (total ions about 900 mg/L) as compared to Boggy Creek well field (total ions 840 to 1511 mg/L) suggest that the former may receive a greater proportion of its water via the Condie Aquifer or Boggy Creek. Boggy Creek well field may be getting more of its water via infiltration through overlying tills which would tend to impart a greater concentration of total ions.

In the area where the Condie Aquifer overlies the Upper Floral Formation Sands and Gravels, the hydraulic head in the Condie Aquifer appears to be slightly higher than in the underlying aquifer zones (see Maps No. 6 and No. 7). These data suggest that there may be significant flow down from the Condie Aquifer. In the absence of more detailed hydrogeologic and water-level data, the magnitude of this downward flow cannot be estimated.

Management of the groundwater resources in the area east of the Boggy Creek and Mallory Springs well fields will require a better understanding of the groundwater regimes. With the present state of knowledge the maximum yield of the well fields cannot be reliably assessed, nor is it possible to predict how industrial or agricultural activities might influence the quantity and quality of the groundwater pumped at the well fields and elsewhere in the area.

7. GROUNDWATER RESOURCES OF THE LOWER FLORAL FORMATION SANDS AND GRAVELS

7.1 Extent of Lower Floral Formation Sands and Gravels

The extent, depth to, and thickness of the Lower Floral Sand and Gravel unit is indicated on Map No. 5. The extent largely coincides with that presented by Christiansen (1979a, drawing 0016-003-20). However, re-interpretation of some testhole data has resulted in a decrease of extent in Range 20, Township 18. Again it should be noted that the extent is inferred and does not necessarily imply that the sands and gravels are continuous within the area.

The occurrence of Lower Floral Sands and Gravels is mainly limited to the northern part of the study area. Isolated occurrences of these sands and gravels are encountered in Ranges 20 and 21, Township 18, and in Range 21, Townships 15 and 16.

The depth below ground surface at which the Lower Floral Formation Sands and Gravels are encountered may range from 14 metres to 104 metres, depending on the geological setting. Its thickness may range from 4 to 35 metres.

7.2 Definition of Aquifers

From a hydrogeological point of view the Lower Floral Formation Sands and Gravels form aquifer zones. However, insufficient geological and groundwater data are available to justify naming particular aquifer zones. Consequently, aquifer zones formed by this geological unit are referred to as aquifer zones of the Lower Floral Formation.

7.3 Water Levels

Water level data for the Lower Floral aquifer zones are detailed in Appendix B and data for the period 1970 - 1985 are plotted on Map No. 8.

All water level data are for unsurveyed wells, except for the static water levels in the Mound Springs well field. These static water levels are shown lying in a range of 589.3 m to more than 593.2 m (flowing well), this variation being mostly due to the pumping history of the well field up to the time that the static (non-pumping) level was measured.

Inspection of the data plotted on Map No. 8 shows that the water levels in the farm wells near the Mound Springs well field appear to be continuous with the static levels in the well field. There is some indication of a rise in water level to the east, the direction from which the groundwater flow presumably comes to feed Mound Springs.

In the Zehner area (Ranges 17 and 18, Townships 18 and 19), the water level data are erratic. There is a suggestion of a continuous piezometric surface with the hydraulic head rising from about 596 m to about 614 m, in a northeasterly direction, which may also be continuous with the Boggy Creek well field (heads of about 590 m). However, there are also several much higher values ranging from about 626 to 658 metres. These higher values suggest the existence of overlying aquifer zones. The erratic hydraulic head data (see also the data for the Upper Floral Sands and Gravels, Map No. 7) indicate that the identity, continuity, and extent of the aquifer zones are not yet well-known. (It is for this reason that no aquifer names have been assigned to these aquifer zones.)

The groundwater levels at Mound Springs correspond to the elevation of surface streams passing through the area. The occurrence of Dixon and Cooper Springs south-west of Mound Springs (Range 20, Township 19), described by Hill et al (1930), may be related to the western edge of the Lower Floral Sands and Gravels.

7.4 Groundwater Withdrawals and Water-level Changes

Mound Springs well field represents the only large withdrawals directly from the Lower Floral Sands and Gravels. Groundwater has been pumped from this well field starting in 1930 to the present at rates of 500 dam^3 per year in the 1930's and rising up to 2500 dam^3 per year in recent years (see Appendix C). The average withdrawal rate for the period 1969 to 1984 has been 1890 dam^3 per year.

The following data, taken from Appendix B, show how static water levels have changed in the Mound Springs well field since 1929.

Well No. 1	1929	about	602 m
Well No. 2	1929	about	601 m
14A	1940	above	597.83 m
9G	1944		593.75 m
M1	1962		595.45 m
1-67	1967		591.74 m
M3	1985	above	593.20 m

Wells No. 1 and No. 2, reported by Hill et al (1930) were probably drawing water from the Upper Floral aquifer zones, also present in the well field area. The water levels in the underlying Lower Floral aquifer zones would probably have been somewhat higher. The water level data indicate that the original static levels in 1929 were slightly above 600 m, fell by a few metres in subsequent years because of pumping, but still rose to above 593 m in 1985 when pumping ceased for a while.

These relatively small drawdowns can be considered the normal consequence of pumping and do not necessarily imply significant depletion of the groundwater reserves. It may be concluded that the inter-till aquifer zones east of Mound Springs, which supply the well field, probably have a total recharge rate in excess of 2000 dam^3 per year. The identity, continuity and extent of these zones is however not well-defined at present.

It seems likely that the Lower Floral aquifer zones north-east of the Boggy Creek well field contribute to the groundwater production from this well field. However, the geological and water level data are insufficient to allow any conclusions on this possibility.

7.5 Hydraulic Properties

The only data for transmissivity of the Lower Floral Sands and Gravels comes from two pumping tests conducted at Mound Springs well field. Lissey (1962) reported a transmissivity of 1.3×10^{-3} m^2/sec from a test on well 9G. Mollard (1967A) reported value of 2.2×10^{-3} m^2/sec for well PW2-H1967. These two values give an average of 1.8×10^{-3} m^2/sec (160 m^2/day).

7.6 Groundwater Quality

Based on the present knowledge, chemical analyses representing Lower Floral Formation aquifer zones have been identified and are marked in Table D-1 (Appendix D). On Map No. 8 the sum of ions and water type has been indicated for the sample locations. The water quality data also are presented in the form of a Piper-plot (Figure 6).

It should be noted (see Map No. 8) that most of the analyses come from a relatively small area, namely from the Mound Springs well field and its vicinity. This limits any discussion of regional water quality patterns.

Water in and in the vicinity of Mound Springs ranges in total concentration from 1035 to 1650 mg/L and is generally of the Ca/Mg - HCO_3 type. The water quality data from individual production wells in the Mound Springs well field show that since 1966 no major changes in water quality have taken place (see Table D-1, Appendix D or Maathuis and Van der Kamp, 1985).

Highly mineralized water of the Ca - SO_4 type occurs in the northern part of Range 19, Township 20, and in the eastern part of Range 17, Township 19. A Lower Floral aquifer zone in Range 21, Townships 15 and 16, appears to yield water with a total concentration in the 1500 to 2000 mg/L range. This water is characterized by a significantly higher sodium concentration than presently is encountered elsewhere in Lower Floral Formation aquifer zones.

7.7 Groundwater Regime

Little data is available with regard to the groundwater regime of the Lower Floral Formation aquifer zones. However it is important to note that the Mound Springs well field has yielded groundwater at rates of about 2000 dam^3 per year with at most only minor lowering of water levels. It is clear therefore that there is considerable recharge to the aquifer zones of the Lower Floral Formation east of the well

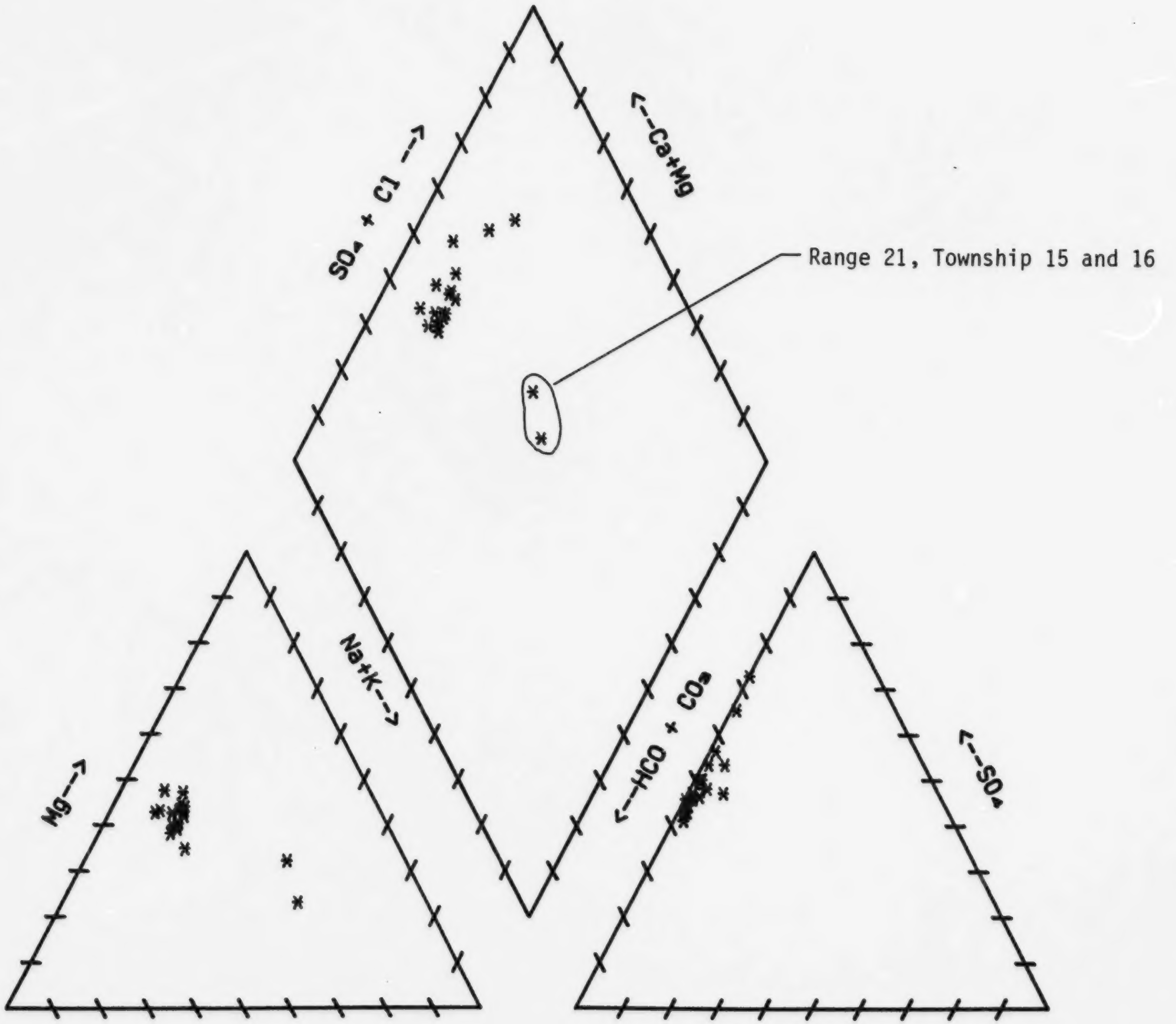


FIGURE 6 PIPER-PLOT OF WATER QUALITY DATA FOR LOWER FLORAL FORMATION SAND AND GRAVEL AQUIFER ZONES

field. This recharge must enter the aquifer zones by vertical flow through the overlying till units. Since the extent and continuity of the aquifer zones are not well known, little can be said about the average rate of recharge per unit area. Upland depressions holding ponded water are probably a major factor in the recharge mechanism. Lateral flow through overlying Upper Floral Formation aquifer zones may contribute to the yield of Mound Springs well fields.

Before the start of groundwater abstractions groundwater from the Lower Floral Formation aquifer zones must have discharged at Mound Springs and probably to the tributaries of Flying Creek, further west.

Presumably there is significant recharge to the Lower Floral Formation aquifer zones north-east of the Boggy Creek well field. Some of this recharged water may make its way to the Boggy Creek well field through overlying Upper Floral Formation aquifer zones.

Considerably more geological, water quality and water-level data are required before reliable interpretation of the flow patterns and flow rates in the aquifer zones of the Lower Floral Formation can be made.

8. DISCUSSION

8.1 Future Use and Development of Groundwater Resources

Total groundwater pumping in the Regina area has averaged about 10,000 dam^3 per year for more than half a century. This water reserve has been an important factor in the growth and industrial development of Regina and probably will always remain so, considering the general water shortage of the area and of southern Saskatchewan.

In some parts of the area, especially in the "Regina Aquifer" area, groundwater has probably been taken from aquifer reserves, but in other parts of the Regina area the pumping has probably intercepted only part of the available recharge. On the very long term the sustained yield of all the aquifers in the Regina area may perhaps be less than 10,000 dam^3/year. However, the volume of water in storage that can be easily withdrawn by pumping may be as large as 1,000,000 dam^3 so that the present rates of withdrawal can certainly be maintained for many years. This large stored volume, together with constant temperature and chemical quality, and lack of evaporative losses, means that groundwater can be viewed as a very reliable source of water supply.

The principal concern with regard to groundwater use in the Regina area comes from contamination. The Condie Aquifer in particular is highly susceptible to contamination because of its surficial and permeable nature. Recharge water entering the Upper Floral Sands and Gravels through the bed of Boggy Creek in Range 17 and 18 could also be easily contaminated. Protecting the aquifers from contamination and locating and cleaning up existing contamination can be a large and difficult task, as witness by the effort that has gone into the PCB spill at the Federal Pioneer Ltd. plant (National Research Council of Canada, 1980).

Artificial recharge could provide an effective and economical means of enhancing the quantity and quality of the groundwater supply and of treating surface water brought in from Buffalo Pound by the natural filtration action of sands. This possibility was discussed by Mollard (1960). The most promising scheme would probably involve infiltration from spreading basins dug into the top of the Condie Moraine Sands and Gravels west of Armour. The Condie Aquifer in this area is essentially a hydrodynamically closed system under present water-level conditions. The recharged water could be recovered by means of properly-spaced collection wells, completed at the bottom of the Condie Aquifer, around the spreading basins. The unsaturated zone in this area is up to 20 metres thick (see Map No. 1) and the storage capacity that could be developed in association with an artificial recharge scheme might amount to 10,000 dam^3 or more. Water moving down through the underlying till would serve to augment recharge to the "Regina Aquifer". In consideration of future water supply options for the City of Regina, such an artificial recharge scheme would appear to deserve serious consideration.

Management of groundwater in the Regina area also has environmental and geotechnical implications. Withdrawal of groudwater has led to drying-up of springs and seepage areas and to lowered water levels, particularly in the "Regina Aquifer". If withdrawals were to be reduced or to cease altogether the groundwater levels would rise and springs that have been dried-up for decades might again begin to flow. The possible impacts of these effects should be considered if withdrawal rates are to be changed.

8.2 Data Requirements

The analysis of groundwater regimes and groundwater quality in the preceding chapters points clearly to important shortcomings in the available data. For instance, the uncertainty as to long-term water-level trends in the western part of the Condie Aquifer results in a major uncertainty as to the source of the water being withdrawn from the "Regina Aquifer". Anywhere from zero to about seventy percent of this water may come from reserves in the Condie Aquifer. Similarly, the scarcity of water quality data for the Condie Aquifer makes it very difficult to identify low-level contamination. As another example, due to a lack of geological data, the source areas for the water being withdrawn from Boggy Creek well field cannot be identified with any certainty.

Sound management of the groundwater resources in the Regina area will require more and better data on hydrogeology, water levels, pumping rates, and water quality. Without such data it will not be possible to evaluate properly the effect of urban, industrial and agricultural developments on groundwater levels, available yield, and groundwater quality. Detailed recommendations as to further data collection are given in the following chapter.

9. RECOMMENDATIONS

9.1 Data Requirements

With regard to geology and hydrogeology the three most important questions to be investigated are:

(1) The nature of the "hydraulic discontinuity" in the Upper Floral Formation in Range 19;

(2) The extent and continuity of the aquifer zones which supply water to Boggy Creek and Mallory Springs well fields;

(3) The hydraulic connection, if any, between the Condie Aquifer and Boggy Creek in the area of the Condie Reservoir.

These questions should be addressed by means of test drilling and appropriate hydrological tests.

The water-quality data base presently available for the principal aquifer zones should be expanded considerably, so as to obtain sufficient background data to allow early detection of low level contamination. This is particularly important for the Condie Aquifer.

Several observation wells should be constructed in each main aquifer or aquifer zone, so as to obtain reliable continuous water-level records. These wells should be sited sufficiently far away from individual production wells that the water-level data will reflect overall water-level trends. In addition, monthly water-level readings should be taken at existing piezometers and unused wells. The air lines on the City's production wells appear to be yielding unreliable data, and should be checked for length of air line and accuracy of pressure gauges.

Withdrawals from the City of Regina production wells are not metered, but calculated by multiplying duration of pumping times and nominal production rate. These withdrawal data are therefore unreliable. The individual wells should be metered.

9.2 Groundwater Resource Management

Water levels in the "Regina Aquifer" are declining steadily, and aquifer reserves are slowly being depleted. Withdrawals from the "Regina Aquifer" should therefore be managed in the light of this factor.

The Condie Aquifer constitutes an important source of groundwater and it is highly susceptible to contamination. This aquifer should therefore be protected from contamination as much as possible, not only in the western half where most of the industrial activity is, but also in the eastern half, where much of the recharge occurs.

Boggy Creek, Mallory Springs and Mound Springs well fields all appear to be capable of sustaining present rates of withdrawals. The capacity of these well fields for increased withdrawal rates should be tested.

It appears that Boggy Creek may act as an important source of recharge to the Upper Floral Formations Sands and Gravels in Ranges 17 and 18. Such recharge water would be highly susceptible to contamination, which could jeopardize the long-term use of the Boggy Creek and Mallory Springs well fields. This potential for contamination should therefore be investigated.

Development and protection of the groundwater resources in the Regina area should be planned with a regional and long-term focus. Small localized studies, dealing with only a small portion of an aquifer, are of little use in evaluating permissible withdrawal rates or possible long-term contamination effects.

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APPENDIX A

CROSS SECTIONS
AND
LOG INDEX

CROSS SECTION LOG INDEX

The cross sections presented in this Appendix are copies of the sections provided by christiansen (1979a). The cross section lines and log numbers are shown on Maps 1 to 8. The log numbers are also the same as used by Christiansen (1979a).

LOG NUMBER	NAME	LAND LOCATION
45	IMP Lunsden	W2-22-20-11-11
46	SRC Craven	W2-21-20-23-09-SE
47	SRC Craven	W2-21-20-14-16-NW
48	SRC Craven	W2-21-20-13-01-NE
49	SRC Craven	W2-20-20-07-08-NE
50	FFIB Vern Harvey	W2-20-20-03-03-SE
51	DOE Regina 507	W2-19-19-31-14-NE
52	FFIB Norman Boswell	W2-19-20-10-04
53	DOE Regina 510	W2-18-19-32-13-NW
54	Reality Read	W2-18-20-09-14
55	SRC Edenwold	W2-17-20-09-05-SW
56	TW Avonhurst	W2-16-19-29-01
79	DOE Regina 520	W2-21-17-32-13-NW
80	DOE Regina 505	W2-21-17-35-13-NW
81	DOE Regina 503	W2-20-17-31-16-NE
82	DOE Regina 517	W2-20-17-34-15-NW
83	DOE Regina 516	W2-10-18-01-01-SE
84	Co-op Regina	W2-19-18-05-01
85	DOE Regina 514	W2-19-18-05-01-NW
86	DOE Regina 509	W2-19-17-33-16-SE

LOG NUMBER	NAME	LAND LOCATION
87	DOE Regina 508	W2-19-17-25-13-SE
88	Hall Kearney	W2-18-17-30-13-SW
89	Pilot Butte	W2-18-17-33-15-NW
90	SDL Pilot Butte	W2-18-18-03-01-SE
91	FFIB Nyles Coulin	W2-17-18-05-01
92	FFIB Jack Kuntz	W2-16-17-31-09-NW
93	Solie McLean	W2-16-17-27-05-SW
94	FFIB J. Laturnas	W2-15-17-08-16-NE
95	Argo. Argo Nurd	W2-15-17-11-01-SE
240	Socony Estlin #1	W2-19-15-20-01
241	SRC Estlin	W2-19-15-20-14-NW
242	FFIB S. Kostrom	W2-20-16-02-01
243	SRC Rowatt	W2-10-16-22-16-NE
244	SPC Regina	W2-20-16-27-09
245	DOE Regina 524	W2-20-16-34-13-NW
246	DOE Regina 523	W2-20-17-10-09-NE
247	P.Am Regina	W2-20-17-09-16
248	DOE Regina 512	W2-20-17-23-01-NW
249	DOE Regina 511	W2-19-17-30-12-SW
250	DOE Regina 513	W2-19-17-32-04-NW
251	IMP Regina	W2-19-17-32-04
252	DOE Regina 515	W2-19-18-04-14-SE
253	DOE Regina 519	W2-19-18-10-12-SW
254	DOE Regina 501	W2-19-18-15-08-SE
255	Hall Seibel Creek	W2-19-18-24-02-SE
256	Hall Zehner	W2-18-18-31-04-SE

LOG NUMBER	NAME	LAND LOCATION
257	SRC Zehner	W2-18-18-32-13-NW
258	SDL Zehner	W2-18-19-22-13-SE
259	Hall Qu'Appelle River	W2-19-20-36-14-SW

APPENDIX B

WATER LEVEL DATA

APPENDIX B - WATER LEVEL DATA

Explanation of symbols and abbreviations

1. WELL LOCATION

   Municipal land location: Meridian - Range - Township - Section - - (Legal Subdivision) - Quarter.

2. WELL NAME OR NUMBER

   Name or number by which well is identified in data source.

3. DATA SOURCE

   Source from which the well and water-level data are taken. Where the source is a report this is indicated by author and year, e.g. Beckie (19)77. These reports are listed under References in the main report. Other sources are:

   DOE - Saskatchewan Environment Ground Water Data Report.

   FFIB - Logs and well data collected under the Family Farm Improvement Branch well assistance program.

   SRC - Logs and well data collected by Saskatchewan Research Council staff.

   Regina PWED - City of Regina, Public Works and Engineering Department.

   SRC Tp File - Miscellaneous well logs held in SRC's Township files.

   SRC Records - Water level records collected from SRC's observation well network.

4. DATUM ELEV METERS

   Elevation of datum used, or assumed to have been used, for water level measurements, in meters above mean sea level.

5. DATUM TYPE

   Description of datum used:

GRD - ground level
CAS - top of casing
PHF - pump house floor

(note: when datum type is not given by data source, ground level is assumed).

6. CAS HT M

Height of top of casing above ground level (may be negative if well has a pit).

7. DAT ACC

Estimate of realiability of datum elevation

A - within 0.025 meter (accurate survey)
B - within 0.25 meter (approximate survey)
C - within 2.5 meter (estimated from 1:50,000 topographic contours)

8. FM

Formation in which well is completed

CM - Condie Moraine Sands and Gravels
UF - Upper Floral Sands and Gravels
IGS - Interglacial Sediments
LF - Lower Floral Sands and Gravels
E - Empress Group Sands and Gravels

9. TOP OF SCREEN METERS

Length in meters to top of screen, from datum.

10. SCREEN BOTTOM METERS

Length in meters to bottom of screen, from datum.

11. STATIC WATERLV METERS

Measured static water level below datum in meters. If datum type is not given in data source, the datum is assumed to be ground level. Flowing wells are indicated by - 0.00.

12. WATERLV ELEV METERS

Elevation of static water level in meters above mean sea level.

13. WLV ACC

Estimate of reliability of water-level elevation.

A - within 0.025 meters

B - within 0.25 meters

C - within 2.5 meters

Note that water-level accuracy cannot be better than datum accuracy, but may be worse.

14. DATE YYMMDD

Date of water-level measurement - year, month, day

e.g. Nov. 23, 1983 = 831123

November 1983 = 8311

1983 = 83

15. REMARKS

APPENDIX B - WATER LEVEL DATA

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	FM	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	WLV ACC	DATE YYMMDD	REMARKS
W2-16-16-16-NW	ALEX EBERLE	DOE	647.70	GRD	?	C	?	24.08	25.60	9.14	638.56	C	790919	
W2-16-17-12-NW	ROSOM BROTHERS	DOE	676.66	GRD	?	C	?	43.59	45.11	9.45	667.21	C	630815	
W2-16-17-15-SW	H WESLOWSKI	DOE	670.56	GRD	?	C	?	35.05	36.58	1.83	668.73	C	631101	
W2-16-17-17-SW	R.COPLAND	DOE	665.99	GRD	?	C	?	32.00	33.53	16.76	649.23	C	721012	
W2-16-17-17-SW	R.COPLAND	DOE	662.94	GRD	?	C	?	33.83	35.36	9.14	653.80	C	780816	
W2-16-17-24-SE	G.BECKER	DOE	685.80	GRD	?	C	?	64.92	65.84	18.29	667.51	C	620511	
W2-16-17-28-SE	T.KESSEL	DOE	685.80	GRD	?	C	?	42.67	45.72	16.46	669.34	C	780714	
W2-16-17-28-SW	J.DIEWOLD	DOE	681.23	GRD	?	C	?	36.88	38.10	19.81	661.42	C	690926	
W2-16-17-34-SE	PHILIP LIEBEL	DOE	685.80	GRD	?	C	?	28.96	30.48	18.90	666.90	C	60	
W2-16-17-35-NE	C.SANSON	DOE	685.80	GRD	?	C	?	28.65	29.57	8.53	677.27	C	620427	
W2-16-18-05-SE	RALPH KESSEL	DOE	690.37	GRD	?	C	?	24.38	27.13	18.93	671.44	C	60	
W2-16-18-08-NW	GEORGE EBENAL	DOE	693.42	GRD	?	C	?	44.20	45.72	12.19	681.23	C	720927	
W2-16-18-09-SE	LAWRENCE GETZ	DOE	693.42	GRD	?	C	?	32.61	34.11	22.56	670.86	C	720514	
W2-16-18-11-SW	MCLEAN CAMPSITE	DOE	693.72	GRD	?	C	?	76.20	79.25	27.13	666.59	C	810881	
W2-16-18-11-SW	MCLEAN PARKWELL	DOE	691.90	GRD	?	C	?	77.11	79.25	24.99	666.91	C	621017	
W2-16-18-13-SE	J.ASHWORTH	DOE	693.42	GRD	?	C	?			25.91	667.51	C	460912	OPEN HOLE
W2-16-18-13-SE	MCLEAN	DOE	699.21	GRD	?	C	?	74.68	79.25	27.74	671.47	C	70	
W2-16-18-16-NE	G. FORESTER	DOE	699.52	GRD	?	C	?	37.49	39.01	22.86	676.66	C	830330	
W2-16-18-17-NE	EMIL WAGNER	DOE	697.99	GRD	?	C	?			26.82	671.17	C	460504	OPEN HOLE
W2-16-18-17-NW	MIKE WAGNER	DOE	701.04	GRD	?	C	?	72.85	74.37	54.86	646.18	C	810605	
W2-16-18-18	G.BECKER	DOE	696.47	GRD	?	C	?	66.45	67.67	18.29	678.18	C	790927	
W2-16-18-19-NE	K.DONNELLY	DOE	696.47	GRD	?	C	?	34.14	35.66	13.72	682.75	C	790927	
W2-16-18-19-SE	P.YAKYNYK	DOE	701.04	GRD	?	C	?	50.29	51.82	17.37	683.67	C	800915	
W2-16-18-20-SW	T.BECKETT	DOE	701.04	GRD	?	C	?	42.67	44.20	17.98	683.06	C	790926	
W2-16-18-28-SW	G.ECKSTEIN	DOE	693.42	GRD	?	C	?	46.63	48.16	24.69	668.73	C	770829	
W2-16-18-29-SE	JACK MCMUNN	DOE	701.04	GRD	?	C	?	39.01	42.67	23.77	677.27	C	800701	
W2-16-18-32-SE	W.GILLERT	DOE	701.04	GRD	?	C	?	114.91	117.96	87.48	613.56	C	810721	
W2-16-18-33-SE	R.GALE'ZOSKI	DOE	701.04	GRD	?	C	?	77.72	79.51	19.51	681.53	C	760709	
W2-16-19-04-SW	R.LINDENBACK	DOE	701.04	GRD	?	C	?	56.69	58.22	22.86	678.18	C	731001	
W2-16-19-08-NW	GRACE LINDENBACK	DOE	676.66	GRD	?	C	?	58.83	60.35	14.94	661.72	C	74	
W2-16-19-20-NE	K.SCHULZ	DOE	665.99	GRD	?	C	?	79.55	81.08	18.29	647.70	C	791004	
W2-16-19-31-NW	E.KOCH	DOE	649.22	GRD	?	C	?	74.98	76.50	16.76	649.22	C	800506	
W2-16-19-31-NW	F.KOCH	DOE	650.75	GRD	?	C	?			15.85	634.90	C	320610	OPEN HOLE
W2-16-20-05-NW	RAYMOND KRAMER	DOE	640.08	GRD	?	C	?	60.66	62.18	32.00	608.08	C	800331	
W2-17-17-19-13	D.A.A.B.	SRC	617.22	GRD	?	C	CM	4.88	6.40	4.57	612.65	C	7004	SWL FROM E-LOG
W2-17-18-04-NE	BALGONIE TEST WELL	STOCK 63	664.46	GRD	?	C	UF	27.13	30.18	19.05	645.41	C	630309	
W2-17-18-04-NE	OBS WELL	SASK ENV. 70	664.46	GRD	?	C	UF	?	?	22.78	641.69	C	700610	
W2-17-18-04-NE	WELL #2	SASK ENV. 70	664.46	GRD	?	C	UF	26.52	28.96	23.23	641.24	C	700610	
W2-17-18-07-NE	OBS 1-75	MOLLARD 75	655.32	GRD	0.46	C	UF	30.78	35.05	18.02	637.30	C	750603	
W2-17-18-22-NW	T.HUBER	FFIB LOG	678.18	GRD	?	C	?	65.84	68.88	44.50	633.68	C	781030	
W2-17-19-14-15-NW	W.H.REICHEL	SRC	673.61	GRD	?	C	LF	105.77	108.81	15.24	658.37	C	7308	CORRECT STATIC?
W2-17-21-12-SE	WILLIAM LUEYK	DOE	594.36	GRD	?	C	?	74.07	77.11	12.19	582.17	C	811114	
W2-18-17-10-SW	G.BROCK	DOE	586.74	GRD	?	C	?	12.80	15.24	11.58	575.16	C	790913	SCREEN ALSO 28.96-34.75
W2-18-17-18-SW	WATT	WYNNE-ROB 12	583.69	GRD	?	C	?	?	36.58	-0.00	+583.69	C	12	FLOWING WELL
W2-18-17-20-SE	BUFFALO LOOKOUT	DOE	594.36	GRD	?	C	?	22.86	25.91	16.15	578.21	C	670525	
W2-18-17-21-13-NW	R.ELRCO	SRC	603.50	GRD	?	C	CM	12.19	15.24	5.49	598.02	C	700716	

APPENDIX B - WATER LEVEL DATA

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	FM	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	WLV ACC	DATE YYMMDD	REMARKS
W2-18-17-24-SW	DADS COOKIES	DOE	609.60	GRD	?	C	?	23.77	25.30	2.74	606.86	C	6508	
W2-18-17-26-05-NW	OBS WELL #2	BECKIE 77	617.22	GRD	0.15	C	CM	8.69	9.14	2.38	614.84	C	7703	
W2-18-17-29-12	OBS 85-3	BECKIE 85	600.00	CAS	?	C	UF	39.01	39.92	13.10	586.90	C	850328	
W2-18-17-29-13	OBS 85-1	BECKIE 85	598.00	CAS	?	C	UF	54.24	55.15	12.08	585.92	C	850328	
W2-18-17-30-13-NW	H.ZINKHAM	DOE	594.36	GRD	?	C	UF	50.29	51.82	7.32	587.04	C	7306	
W2-18-17-30-SE	EMBURY #1	HILL 30	594.36	GRD	?	C	UF	24.38	38.10	0.30	594.06	C	2810	SEE P.96 REPORT
W2-18-17-30-SE	EMBURY #2	HILL 30	594.36	GRD	?	C	UF	39.32	46.02	-0.61	594.97	C	2810	LISTED WELL
W2-18-17-30-SE	LADYRAND ENT. LTD.	DOE	594.36	GRD	?	C	UF	42.67	45.72	15.24	579.12	C	790625	
W2-18-17-31-NE	CITY OF REGINA #6	DOE	605.03	GRD	?	C	CM	18.29	19.81	13.11	591.92	C	610816	ABANDONED
W2-18-17-31-NW	CITY OF REGINA #5	DOE	601.98	GRD	?	C	UF	46.94	48.46	4.88	597.10	C	610816	ABANDONED
W2-18-17-32-08-NW	OBS 6-84	BECKIE 84	607.19	GRD	1.24	A	CM	15.24	15.85	6.23	600.96	A	840504	
W2-18-17-33-15-NW	SOLIE DRILLING	SRC	620.27	GRD	?	C	CM	?	?	10.67	609.60	C	740603	SWL FROM E-LOG
W2-18-17-33-16-NW	OBS 5-84	BECKIE 84	617.81	GRD	1.07	A	CM	13.41	14.02	7.58	610.23	A	840503	
W2-18-17-35-04-NW	#2 TRIAL WELL	BECKIE 77	617.22	GRD	0.46	C	?	18.59	21.64	2.44	614.78	C	7703	
W2-18-17-35-04-NW	OBS WELL #5	BECKIE 77	617.22	GRD	0.46	C	CM	8.69	9.14	2.44	614.78	C	7703	
W2-18-18-03-SE	PRAIRIE FEEDERS	DOE	617.22	GRD	?	C	?	24.99	28.04	3.05	614.17	C	690526	
W2-18-18-03-SW	R.KOLB	DOE	617.22	GRD	?	C	?	26.82	28.35	9.14	608.08	C	710929	
W2-18-18-06-SE	CITY OF REGINA #12	DOE	609.60	GRD	?	C	CM	31.70	33.22	12.19	597.41	C	610823	
W2-18-18-07-05-SW	OBS WELL #1	AESL 77	602.14	CAS	?	A	CM	12.80	13.72	1.93	600.21	A	770613	
W2-18-18-07-NE	BC-5	REGINA PWED	605.79	GRD	?	B	UF	45.11	57.91	10.15	595.64	B	770426	DRILLED
W2-18-18-07-NE	BC-5	MLM 80	605.79	PHF	?	B	UF	45.11	57.91	11.58	594.21	B	80	1 OBS WELL
W2-18-18-07-NE	BC6A	MLM 82	617.22	GRD	0.34	A	UF	62.48	68.58	20.98	596.24	A	820511	DRILLED
W2-18-18-07-NE	BOYS SCOUT ASSOC.	DOE	609.60	GRD	?	C	UF	23.77	29.87	12.19	597.41	C	540621	
W2-18-18-07-NE	P-60	LISSEY 62	605.73	GRD	0.13	B	UF	51.82	57.91	7.77	597.96	C	600630	SWL WHEN DRILLED
W2-18-18-07-NE	P-60	LISSEY 62	605.73	GRD	0.13	B	UF	51.82	57.91	7.80	597.93	B	610114	2 OBS WELLS
W2-18-18-07-NE	TH 81-2	MLM 82	618.53	GRD	0.70	A	UF	65.53	68.58	25.69	592.84	A	811116	
W2-18-18-07-NE	TH 81-2	MLM 82	618.53	CAS	0.70	A	UF	65.53	68.58	22.11	596.42	A	820511	
W2-18-18-07-NW	CITY OF REGINA	DOE	601.98	GRD	?	C	UF	33.53	35.05	3.96	598.02	C	610912	4" OBS WELL
W2-18-18-08-12-NE	OBS WELL #5	AESL 77	612.42	CAS	?	A	CM	12.80	13.72	6.40	606.02	A	770613	
W2-18-18-08-NE	J.W.ZALUSKY	DOE	617.22	GRD	?	C	UF	17.68	18.90	14.02	603.20	C	650512	
W2-18-18-08-SE	ZALUSKY SAND&GRAVEL	DOE	620.27	GRD	?	C	CM	17.98	19.51	13.41	606.86	C	680925	
W2-18-18-10-16-NE	#3 TRIAL WELL	BECKIE 77	629.41	GRD	0.46	C	UF	19.81	22.86	8.23	621.18	C	770518	
W2-18-18-12-NW	CITY OF REGINA	DOE	632.46	GRD	?	C	UF	26.82	28.65	24.08	608.38	C	610914	4" OBS WELL
W2-18-18-14-SW	PASQUA PAVING	DOE	632.46	GRD	?	C	UF	0.00	26.21	5.49	626.97	C	770512	
W2-18-18-16-SE	J.KUFFNER	DOE	624.84	GRD	?	C	?	42.98	44.50	27.43	597.41	C	721023	
W2-18-18-21-NE	R.BRODT	DOE	640.08	GRD	?	C	UF	52.12	53.64	39.01	601.07	C	6508	
W2-18-18-21-NW	POSHEN & WISSBROD	FFIB	640.08	GRD	?	C	LF	62.18	65.23	34.14	605.94	C	790917	
W2-18-18-22-NW	G.GOTTSELIG	DOE	640.08	GRD	?	C	UF	50.60	52.12	27.43	612.65	C	731219	
W2-18-18-22-SE	A.WOLF	DOE	640.08	GRD	?	C	UF	28.35	29.87	14.63	625.45	C	630123	
W2-18-18-24-NW	T.WARD	DOE	650.75	GRD	?	C	LF	58.22	59.74	42.06	608.69	C	711207	
W2-18-18-31-SW	H.JOWSEY	DOE	624.84	GRD	?	C	UF	45.11	46.63	28.65	596.19	C	7307	
W2-18-18-32-NW	R.HOFFMAN	DOE	644.96	GRD	?	C	LF	53.64	57.0C	48.77	596.19	C	680918	
W2-18-18-32-NW	R.HOFFMAN	DOE	647.70	GRD	?	C	LF	64.01	65.53	21.34	626.36	C	760930	
W2-18-18-33-NE	J.FRITZ	DOE	658.37	GRD	?	C	LF	64.01	65.53	48.16	610.21	C	770720	
W2-18-18-33-SE	J.FRITZ	DOE	655.32	GRD	?	C	LF	64.01	65.53	48.16	607.16	C	740613	
W2-18-18-34-NW	G.BEATTIE	FFIB	656.84	GRD	?	C	LF	62.48	64.01	17.37	639.47	C	810621	
W2-18-18-36	GOV'T WELL	WYNNE-ROB 12	670.56	GRD	?	C	?	?	61.57	32.61	637.95	C	12	

APPENDIX B - WATER LEVEL DATA

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	FM	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	WLV ACC	DATE YYMMDD	REMARKS
W2-18-19-01-05-NW	W.B.THOMPSON	FFIB	673.61	GRD	?	C	LF	66.75	68.28	59.44	614.17	C	7704	
W2-18-19-03-SE	J.KNUBBEN	FFIB	661.42	GRD	?	C	LF	57.91	59.44	9.75	651.66	C	811009	
W2-18-19-22-13-SE	J.FOLEY	SRC	673.61	GRD	?	C	UF	54.86	56.39	54.25	619.35	C	700324	
W2-18-19-29-SW	SEITZ BROS. DAIRY	FFIB	664.46	GRD	?	C	UF	57.91	59.44	52.73	611.73	C	810312	
W2-18-19-34-15-NE	J.WSZALEK	FFIB	676.66	GRD	?	C	LF	86.26	87.78	71.63	605.03	C	810325	
W2-19-16-21	GERMAN COLONY	WYNNE-ROB 12	575.00	GRD	?	C	?	?	12.80	-0.00	+575.00	C	12	FLOWING WELL
W2-19-16-33-NW	TH10-BR60	LISSEY 62	573.54	GRD	2.97	B	UF	6.71	16.76	-2.51	576.05	B	601102	FLOWING WELL
W2-19-16-34-NW	J.F.HUGILL	FFIB	575.00	GRD	?	C	UF	18.59	20.12	-0.00	+575.00	C	7306	FLOWING WELL
W2-19-17-01-02-NW	F.SCHNEIDER	SRC	575.00	GRD	?	C	UF	28.96	30.48	1.52	573.48	C	7105	
W2-19-17-01-NW	L.ROGER	DOE	576.07	GRD	?	C	UF	18.90	20.42	3.05	573.02	C	710917	
W2-19-17-01-NW	T.CURRAN	DOE/SRC	576.07	GRD	?	C	UF	15.54	17.07	3.35	572.72	C	690826	
W2-19-17-01-SW	F.SCHNEIDER	DOE/SRC	576.07	GRD	?	C	UF	23.47	24.99	0.30	575.77	C	6906	
W2-19-17-02-SE	J.HERTH	DOE	575.00	GRD	?	C	UF	21.34	22.86	3.66	571.34	C	790924	
W2-19-17-19	EMMIGRATION HALL	WYNNE-ROB 12	576.07	GRD	?	C	IGS	?	30.48	7.62	568.45	C	12	
W2-19-17-19-NW	CITY OF REGINA	DOE	579.12	GRD	?	C	IGS	?	54.86	19.35	559.77	C	4910	OPEN HOLE
W2-19-17-19-NW	PALM DAIRY	DOE	579.12	GRD	?	C	IGS	56.69	59.74	16.76	562.36	C	550222	
W2-19-17-19-NW	SILVERWOOD DAIRY	DOE	579.12	GRD	?	C	IGS	54.86	57.00	19.20	559.92	C	6409	
W2-19-17-19-NW	VICTORIA PARK PD#1	LISSEY 62	576.07	GRD	?	C	IGS	?	54.25	19.35	556.72	C	620309	DRILLED APR/50
W2-19-17-19-SE	SICKS BREWERY	DOE	573.02	GRD	?	C	IGS	22.25	25.91	15.24	557.78	C	500117	
W2-19-17-19-SE	SICKS BREWERY	DOE	576.07	GRD	?	C	IGS	63.70	67.06	15.85	560.22	C	500301	
W2-19-17-24-NE	K.MILLER	DOE	586.74	GRD	?	C	E	77.42	78.94	4.88	581.86	C	6812	
W2-19-17-24-NW	W.T.COWLEY	DOE	586.74	GRD	?	C	CM	13.72	15.24	11.28	575.46	C	560705	
W2-19-17-24-SE	G.LITOWSKI	DOE	586.74	GRD	?	C	CM	?	10.36	6.10	580.64	C	7004167	
W2-19-17-24-SE	J.OXMAN	DOE	586.74	GRD	?	C	CM	9.14	10.67	6.10	580.64	C	650723	
W2-19-17-25-NW	KELLY 1	HILL 30	585.20	CAS	?	A	UF	31.39	42.37	4.27	580.93	B	29	P.86
W2-19-17-25-NW	KELLY 1	LISSEY 62/DOE	585.20	CAS	?	A	UF	31.39	42.37	2.74	582.46	B	29	DRILLED
W2-19-17-25-NW	KELLY 1	MOLLARD 67	585.20	PHF	?	A	UF	31.39	42.37	4.97	580.22	A	670309	
W2-19-17-25-NW	KELLY 1	REGINA PWED	585.20	CAS	?	A	UF	31.39	42.37	-0.00	+585.20	B	850124	WELL FLOWING
W2-19-17-25-NW	KELLY 2	DOE	586.50	CAS	?	A	UF	30.78	42.37	3.66	582.84	B	29	DRILLED
W2-19-17-25-NW	KELLY 2	MOLLARD 67	586.50	PHF	?	A	UF	30.78	42.37	6.29	580.21	A	670309	
W2-19-17-25-NW	P1-H67	MOLLARD 67	585.40	GRD	0.46	A	UF	31.09	42.67	5.04	580.35	A	670308	DRILLED
W2-19-17-25-NW	P1-H67	REGINA PWED	585.52	GRD	?	B	UF	29.87	42.67	-0.00	+585.52	C	851011	WELL FLOWING
W2-19-17-26-SW	CITY OF REGINA	DOE	579.12	GRD	?	C	?	46.94	48.46	6.10	573.02	C	N/A	6" WELL 1961?
W2-19-17-30-03	LEADER PUBL.	HILL 30	574.55	GRD	?	C	IGS	?	39.62	12.50	562.05	C	29	SEE P.24
W2-19-17-30-03	McCALLUMN HILL	HILL 30	574.55	GRD	?	C	IGS	?	60.05	12.80	561.75	C	29	SEE P.24
W2-19-17-30-03	McCALLUNM HILL	HILL 30	574.55	GRD	?	C	IGS	?	60.05	13.72	560.83	C	29	SEE P.24
W2-19-17-30-04	ADANAC BREWERY	HILL 30	574.55	GRD	?	C	IGS	?	59.44	12.19	562.36	C	29	SEE P.24
W2-19-17-30-06-NE	SIMPSONS SEARS	DOE	579.12	GRD	?	C	UF	29.57	35.66	16.76	562.36	C	510111	
W2-19-17-30-06-NE	SIMPSONS SEARS	DOE/SRC	579.12	GRD	?	C	UF	36.88	39.93	20.73	558.39	C	7109	
W2-19-17-30-08	REGINA BREWERY	HILL 30	576.07	GRD	?	C	IGS	?	85.34	12.19	563.88	C	29	SEE P.24
W2-19-17-30-10	WELL #2 CITY YARD	HILL 30	577.60	GRD	?	C	IGS	56.08	58.52	12.19	565.40	C	29	SEE P.81
W2-19-17-30-10	WESTRN MAN CO.	HILL 30	576.07	GRD	?	C	IGS	?	63.70	12.19	563.88	C	29	SEE P.24
W2-19-17-30-NE	C4	LISSEY 62/DOE	579.12	GRD	?	C	IGS	51.82	56.39	12.95	566.17	C	4808	DRILLED SEE P.83
W2-19-17-30-NE	C4	LISSEY 62	579.12	PHF	-2.02	C	IGS	51.82	56.39	19.02	560.10	C	62	
W2-19-17-30-NE	TH82-1 C OF REGINA	REGINA PWED	577.29	CAS	?	A	IGS	46.63	51.21	20.47	556.82	A	821202	
W2-19-17-30-NW	CARLINGS BREWERY	DOE	579.12	GRD	?	C	IGS	45.72	60.35	18.29	560.83	C	600705	
W2-19-17-30-NW	CARLINGS BREWERY	DOE	579.12	GRD	?	C	IGS	54.56	59.13	21.03	558.09	C	621108	

APPENDIX B - WATER LEVEL DATA

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	FM	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	WLV ACC	DATE YYMMDD	REMARKS
W2-19-17-30-NW	CARLINGS BREWERY	MLM 1980	579.12	CAS	?	C	IGS	?	?	19.30	559.16	C	80	
W2-19-17-30-SE	SASK CO-OP CREAMERY	DOE	579.12	GRD	?	C	UF	59.44	64.01	21.34	557.78	C	670920	
W2-19-17-30-SW	PD #2 4 AVE CEM.	LISSEY 62/DOE	574.55	GRD	?	C	IGS	49.68	57.61	15.85	558.70	C	58	SEE P.84
W2-19-17-30-SW	PD #2 4 AVE CEM.	LISSEY 62	574.55	GRD	0.30	C	IGS	49.68	57.61	16.73	557.81	C	6203	SEE P.34
W2-19-17-30-SW	T.EATONS	DOE	579.12	GRD	?	C	UF	20.42	28.96	13.72	565.40	C	380623	
W2-19-17-30-SW	WELL R8	REGINA PWED	577.29	CAS	?	C	IGS	41.76	50.29	20.01	557.28	C	821202	DRILLED (SEE TH82-3)
W2-19-17-32	IMP OIL REF #19	MOLLARD 60	582.17	GRD	?	C	UF	?	?	19.20	562.97	C	3805	
W2-19-17-32	IMP OIL REF #19	MOLLARD 60	582.17	GRD	?	C	UF	?	?	18.90	563.27	C	4205	
W2-19-17-32-05	IMP OIL REF #23	SRC	582.17	GRD	?	C	UF	?	?	23.77	558.39	C		
W2-19-17-32-05-NW	IMP OIL REF #20	SRC TP FILE	583.20	CAS	?	B	UF	25.60	34.75	20.42	562.66	B	4309	DRILLED
W2-19-17-32-05-NW	IMP OIL REF #20	SRC	583.20	CAS	?	B	UF	25.60	34.75	24.08	559.00	C	53	
W2-19-17-32-05-NW	IMP OIL REF #21	DOE/SRC TP FIL	582.47	CAS	?	C	UF	26.82	33.22	21.34	561.14	C	5004	DRILLED
W2-19-17-32-05-NW	IMP OIL REF #21	SRC	582.47	CAS	?	C	UF	25.91	30.48	24.99	557.48	C	700526	STALBERG E-LOG
W2-19-17-32-05-SW	IMP OIL REF #18	MOLLARD 60	582.78	GRD	?	C	UF	28.04	35.36	19.20	563.58	C	4104	
W2-19-17-32-05-SW	IMP OIL REF #18	SRC TP FILE	582.78	CAS	?	B	UF	28.04	35.36	22.25	560.53	B	5205	DRILLED
W2-19-17-32-05-SW	IMP OIL REF #18	SRC	582.78	CAS	?	B	UF	28.04	35.36	23.16	559.61	C	53	
W2-19-17-32-05-SW	IMP OIL REF #18	SRC	582.78	CAS	?	B	UF	28.04	35.36	24.99	557.78	C	71	
W2-19-17-32-05-SW	IMP OIL REF #18	MLM 80	582.78	CAS	?	B	UF	28.04	35.36	25.02	557.75	B	800729	SEE APPENDIX D
W2-19-17-32-05-SW	IMP OIL REF #23	SRC	582.17	GRD	?	C	UF	?	?	23.47	558.70	C	54	
W2-19-17-32-05-SW	IMP OIL REF #23	SRC DATA	582.17	GRD	?	C	UF	?	?	25.02	557.14	C	7612	
W2-19-17-32-05-SW	IMP OIL REF #24	SRC TP FILE	582.17	CAS	0.46	B	UF	27.28	35.20	25.91	556.26	B	660729	DRILLED
W2-19-17-32-12-SW	IMP OIL REF #25	DOE/SRC TP FIL	582.78	CAS	0.46	B	UF	28.65	31.70	26.91	555.87	B	7209	DRILLED
W2-19-17-32-12-SW	IMP OIL REF #25	MLM 80	582.78	CAS	0.46	B	UF	28.65	31.70	25.59	557.19	B	80	SCREEN 40.8-45.1 APP D
W2-19-17-32-15-NW	CAL #304	CLIFTON 85	586.84	GRD	0.32	A	CM	19.27	20.18	9.30	577.54	A	840925	
W2-19-17-32-16-NE	CAL #307	CLIFTON 85	587.76	GRD	0.85	A	UF	35.90	36.81	31.24	556.52	A	840925	
W2-19-17-32-NW	INTERPROV PIPE	DOE	582.17	GRD	?	C	UF	26.52	32.61	25.91	556.26	C	570712	
W2-19-17-32-SW	OBS #1-102	IOR DATA SHEET	582.17	GRD	?	C	UF	?	?	27.29	554.88	C	730126	WELL NEAR PW20
W2-19-17-33	H.W.LAIRD	WYNNE-ROB 12	585.22	GRD	?	C	UF	?	37.80	23.47	561.75	C	12	LOCATION SOUTH 1/2
W2-19-17-33-14-SW	CAL #310	CLIFTON 85	586.75	GRD	0.57	A	CM	16.33	17.24	7.40	579.35	A	840925	
W2-19-17-33-15-NW	H-8, 1982	CLIFTON 85		GRD	1.60	A	CM	?	13.60		582.12	A	8411	
W2-19-17-34-05-NW	H-10, 1982	CLIFTON 85		GRD	1.30	A	CM	?	10.90	4.70	579.55	B	82	
W2-19-17-34-08-NE	H-7, 1982	CLIFTON 85		GRD	1.30	A	CM	?	8.60		583.86	A	8411	
W2-19-17-35-SW	D.GARDNER	DOE	591.31	GRD	?	C	CM	12.19	15.24	1.52	589.79	C	810505	
W2-19-17-36-SW	W.E.CROSS	DOE	594.36	GRD	?	C	UF	58.52	60.05	17.68	576.68	C	7304	
W2-19-18-02-NE		MACKAY 1936	600.46	GRD	?	C	CM	?	12.8	12.19	588.27	C	35	
W2-19-18-02-SW		MACKAY 1936	600.46	GRD	?	C	CM	?	12.19	11.58	588.87	C	35	
W2-19-18-03	ROWSTON	WYNNE-ROB 12	594.36	GRD	?	C	CM	?	11.89	11.28	583.08	C	12	
W2-19-18-03-04-SW	UTOPIA POULTRY FARM	DOE/SRC	594.36	GRD	?	C	UF	63.70	65.23	38.71	555.65	C	721020	
W2-19-18-03-NE	REGINA LANDFILL MW2	BECKIE 79	598.73	GRD	0.41	A	CM	25.62	27.14	15.02	583.71	A	790621	
W2-19-18-03-NE	REGINA LANDFILL MW2	CLIFTON 85	598.73	GRD	0.41	A	CM	25.62	27.14	14.35	584.38	A	8405	
W2-19-18-03-NW	INLAND CEMENT CO	DOE	601.98	GRD	?	C	CM	26.52	29.57	20.73	581.25	C	5808	
W2-19-18-03-SE	TH2-BR60	LISSEY 62	598.26	GRD	1.10	A	UF	48.77	51.82	38.22	560.04	A	600905	1 OBS WELL
W2-19-18-03-SE	UTOPIA POULTRY FARM	DOE	594.36	GRD	?	C	UF	48.77	51.82	39.01	555.35	C	69	
W2-19-18-03-SW		MACKAY 1936	594.36	GRD	?	C	UF	?	50.29	31.39	562.97	C	35	
W2-19-18-03-SW	REGINA LANDFILL B1	BECKIE	594.97	GRD	?	A	UF	50.9	51.82	36.88	557.78	A	840503	
W2-19-18-03-SW	REGINA LANDFILL MW1	BECKIE 79	593.93	GRD	0.61	A	CM	16.02	19.07	10.43	583.50	A	790621	
W2-19-18-03-SW	REGINA LANDFILL MW1	CLIFTON 85	593.93	GRD	0.61	A	CM	16.02	19.07	9.81	584.12	A	8405	

APPENDIX B - WATER LEVEL DATA

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	FM	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	WLV ACC	DATE YYMMDD	REMARKS
W2-19-18-03-SW	REGINA LANDFILL MW3	BECKIE 79	593.57	GRD	0.35	A	CM	14.76	17.81	10.78	582.79	A	790621	
W2-19-18-03-SW	REGINA LANDFILL MW3	CLIFTON 85	593.57	GRD	0.35	A	CM	14.76	17.81	9.26	584.32	A	8405	
W2-19-18-04	SUTHERLAND	WYNNE-ROB 12	594.36	GRD	?	C	CM	?	11.58	10.36	584.00	C	12	
W2-19-18-04-05-NW	CAL #102	CLIFTON 85	592.33	GRD	0.83	A	CM	10.18	16.47	11.93	580.40	A	820825	
W2-19-18-04-05-NW	CAL #102	CLIFTON 85	592.33	GRD	0.83	A	CM	10.18	16.47	11.81	580.52	A	8411	
W2-19-18-04-11-NW	CAL #309	CLIFTON 85	596.58	GRD	0.79	A	UF	55.02	55.93	39.81	556.77	A	840925	
W2-19-18-04-14-SE	DOE TEST HOLE	SRC	603.50	GRD	?	C	CM	?	?	20.73	582.78	C	741003	SEE E-LOG
W2-19-18-04-SE		MACKAY 1936	591.31	GRD	?	C	CM	?	12.19	10.67	580.64	C	35	
W2-19-18-05-01-SW	CCRL #4	DOE/SRC	587.30	GRD	?	A	UF	37.49	43.59	25.91	561.39	B	5307	DRILLED
W2-19-18-05-01-SW	CCRL #4	SRC TP FILE	587.30	CAS	?	A	UF	37.49	43.59	29.72	557.58	B	651123	
W2-19-18-05-01-SW	CCRL #4	CLIFTON 85	587.30	CAS	?	A	UF	37.49	43.59	?	556.33	B	8411	
W2-19-18-05-01-SW	CCRL #5	CCLR/SRC	588.26	GRD	?	C	UF	40.23	44.81	27.28	560.98	C	5308	SEE CCRL REPORT
W2-19-18-05-03-SE	CCRL #7	SRC TP FILE	565.86	CAS	?	C	UF	38.10	79.25	28.50	557.36	B	680426	DRILLED
W2-19-18-05-04-SE	CAL #106	CLIFTON 85	584.20	GRD	0.64	A	CM	9.33	15.43	12.55	571.63	A	820825	
W2-19-18-05-04-SE	CAL #106	CLIFTON 85	584.20	GRD	0.64	A	CM	9.33	15.43	12.37	571.81	A	8411	
W2-19-18-05-07-SE	CCRL #6	SRC TP FILE	587.41	GRD	0.24	B	UF	35.66	42.67	28.78	558.63	B	610827	DRILLED
W2-19-18-05-07-SE	CCRL #6	SRC TP FILE	587.41	GRD	0.24	B	UF	35.66	42.67	29.63	557.78	B	6505	
W2-19-18-05-07-SE	CCRL #6	SRC	587.41	GRD	0.24	B	UF	35.66	42.67	30.48	557.17	B	670602	
W2-19-18-05-07-SE	CCRL #6	CLIFTON 85	587.41	CAS	?	A	UF	35.66	42.67	?	556.49	B	8411	
W2-19-18-05-13-SE	T.McEACHEN	SRC	591.31	GRD	?	C	CM	?	?	15.54	575.77	C	7304	SWL FROM E-LOG
W2-19-18-05-SE	CCRL	DOE	586.74	GRD	?	C	UF	?	43.28	24.38	562.36	C	3907	
W2-19-18-05-SE	CCRL #3	DOE	588.26	GRD	?	C	UF	41.76	47.85	30.18	558.09	C	500927	
W2-19-18-06	A.ROE	WYNNE-ROB 12	586.74	GRD	?	C	UF	?	36.58	18.29	568.45	C	12	LOCATION SOUTH 1/2
W2-19-18-06	BUTLER	WYNNE-ROB 12	579.12	GRD	?	C	UF	?	41.76	14.33	564.79	C	12	
W2-19-18-06-SE	CITY OF REGINA R5	DOE	583.69	GRD	?	C	UF	32.00	48.77	27.43	556.26	C	6801	DRILLED
W2-19-18-06-SE	TH59-1	MOLLARD 60	583.78	CAS	?	B	UF	24.38	32.31	25.09	558.70	B	59	? SCREEN ? WL
W2-19-18-06-SW	C OF REGINA PIEZ#16	DOE	586.74	GRD	?	C	UF	39.62	41.15	27.43	559.31	C	671003	2" OBS
W2-19-18-06-SW	C OF REGINA PIEZ#18	DOE	586.74	GRD	?	C	UF	38.10	42.67	27.13	559.61	C	671025	6" OBS WELL
W2-19-18-06-SW	CITY OF REGINA R6	DOE	586.74	GRD	?	C	UF	33.53	42.67	27.74	559.00	C	6802	DRILLED
W2-19-18-07-12-NW	H-27, 1983	CLIFTON 85		GRD	?	A	CM	27.30	29.30		571.76	A	8411	
W2-19-18-07-NE	O.WILLIAMS	DOE	589.48	GRD	?	C	UF	48.16	49.68	32.92	556.56	C	630529	
W2-19-18-08-11-SW	H-12B, 1982	CLIFTON 85		GRD	?	A	CM	17.60	18.60	18.00	576.91	B	82	
W2-19-18-08-12-SE	H-21B, 1983	CLIFTON 85		GRD	?	A	UF	44.50	52.15		556.80	A	8411	
W2-19-18-08-12-SE	H-21C, 1983	CLIFTON 85		GRD	?	A	CM	13.40	19.50		575.32	A	8411	
W2-19-18-09-06-NW	H-23, 1983	CLIFTON 85		GRD	0.86	A	CM	12.98	17.98	12.46	582.02	A	830326	
W2-19-18-12	CITY OF REGINA	DOE	594.36	GRD	?	C	UF	44.50	46.33	6.71	587.65	C	610805	4" CASING
W2-19-18-12	CITY OF REGINA	DOE	594.36	GRD	?	C	UF	54.25	55.78	13.72	580.64	C	610809	4" CASING
W2-19-18-12-NE	CITY OF REGINA	DOE	601.98	GRD	?	C	UF	42.67	47.24	13.41	588.57	C	61	6" CASING
W2-19-18-12-NW	CITY OF REGINA	DOE	594.36	GRD	?	C	UF	28.65	33.53	7.01	587.35	C	611023	6" CASING
W2-19-18-12-NW	K3 #168	LISSEY 62/DOE	590.40	GRD	?	B	UF	18.29	29.87	3.96	586.44	C	29	DRILLED
W2-19-18-12-NW	K3 #168	MLM 80	590.40	GRD	?	C	UF	18.29	29.87	11.07	579.33	C	80	
W2-19-18-12-NW	TH1-H61	LISSEY 62	592.47	GRD	0.30	A	UF	28.96	33.53	6.49	585.98	A	611031	
W2-19-18-12-NW	WELL BC-2	DOE	594.36	GRD	?	C	UF	21.95	32.60	4.57	589.79	C	6203	DRILLED
W2-19-18-12-NW	WELL BC-2	MLM 80	594.36	GRD	?	C	UF	21.95	32.61	4.79	589.57	C	80	1 OBS WELL
W2-19-18-12-NW	WELL BC-3	DOE	594.36	GRD	?	C	UF	39.01	49.07	6.71	587.65	C	6311	DRILLED
W2-19-18-12-SE	WELL 166	MLM 80	598.93	GRD	?	C	UF	?	?	6.40	592.53	C	80	
W2-19-18-13-SE	WELL 179	DOE	594.06	GRD	?	C	UF	?	?	1.83	592.23	C	3509	

APPENDIX B - WATER LEVEL DATA

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	FM	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	WLV ACC	DATE YYMMDD	REMARKS
W2-19-18-13-SE	WELL 191	LISSEY 62	594.09	PHF	-2.23	B	UF	34.44	43.59	0.40	593.69	B	440712	P.81
W2-19-18-13-SE	WELL 191	C OF REGINA	594.09	CAS	?	B	UF	34.44	43.59	-0.00	+594.09	B	591006	FLOWING
W2-19-18-13-SE	WELL 191	LISSEY 62	594.09	PHF	-2.23	B	UF	34.44	43.59	3.69	590.40	A	611103	P.81
W2-19-18-13-SE	WELL BC-4	REGINA PWED	594.09	CAS	?	B	UF	27.43	42.67	3.84	590.25	B	760203	DRILLED
W2-19-18-13-SE	WELL BC-4	REGINA PWED	594.09	CAS	?	B	UF	27.43	42.67	-0.00	+594.09	B	851011	FLOWING
W2-19-18-13-SW	WELL 192	DOE	593.14	GRD	?	C	UF	23.16	32.31	6.40	586.74	C	490720	DRILLED
W2-19-18-13-SW	WELL 192	REGINA PWED	593.14	GRD	?	C	UF	23.16	32.31	-0.00	+593.14	C	851011	FLOWING
W2-19-18-14-NE	F.MOLDING	DOE	601.98	GRD	?	C	UF	24.38	25.60	9.75	592.23	C	6310	
W2-19-18-15-NW	R.WATERSON	DOE	597.41	GRD	?	C	?	35.05	36.58	14.33	583.08	C	710714	
W2-19-18-22-SW	H.ZORA	DOE	594.36	GRD	?	C	?	19.81	21.34	9.14	585.22	C	6402	
W2-19-18-24-SE	M.M.KING	DOE/FFIB	609.60	GRD	?	C	UF	32.00	33.53	21.95	587.65	C	7304	
W2-19-18-34-NW	B.BLYTHE	DOE	609.60	GRD	?	C	?	29.26	30.78	7.92	601.68	C	640330	
W2-19-19-01-SE	R.GAGEL	FFIB	629.41	GRD	?	C	E	57.30	60.35	24.38	605.03	C	800612	
W2-19-19-31-12-SE	WELL 9G	LISSEY 62	594.97	PHF	0.15	C	LF	28.96	35.36	-0.00	+594.97	C	4409	SWL WHEN DRILLED
W2-19-19-31-12-SE	WELL 9G	LISSEY 62	594.97	PHF	0.15	A	LF	28.96	35.36	1.32	593.75	A	441027	DRILLED
W2-19-19-31-12-SE	WELL 9G	MOLLARD 67A	595.00	PHF	?	A	LF	28.96	35.36	11.38	583.62	A	670422	OTHER WELLS PUMPING
W2-19-19-31-14-NE	PW2-H-1967	MOLLARD 67A	601.46	GRD	?	A	LF	35.36	48.77	10.46	591.00	A	670421	DRILLED
W2-19-19-31-14-NE	PW2-H-1967	MLM 80	601.46	GRD	3.04	A	LF	35.36	48.77	12.19	589.27	A	80	OTHER WELLS PUMPING
W2-19-19-31-14-NE	TRIAL WELL 1-67	MOLLARD 67A	601.57	GRD	0.33	A	LF	39.62	48.77	9.83	591.74	A	670328	
W2-19-19-31-NW	WELL 14A	REGINA PWED	597.83	GRD	?	A	LF	38.40	44.50	-0.00	+597.83	B	4008	FLOWING WHEN DRILLED
W2-19-19-31-NW	WELL M1	REGINA PWED	596.97	GRD	?	B	LF	33.53	42.06	1.52	595.45	B	6209	SWL WHEN DRILLED
W2-19-19-31-NW	WELL M2	REGINA PWED	594.01	GRD	?	B	LF	20.24	26.34	-0.00	+594.01	B	6209	FLOWING WHEN DRILLED
W2-19-19-31-NW	WELL M3	REGINA PWED	593.20	GRD	?	A	LF	29.15	33.72	-0.00	+593.20	B	6210	FLOWING WHEN DRILLED
W2-19-19-31-NW	WELL M3	REGINA PWED	593.20	GRD	?	A	LF	29.15	33.72	-0.00	+593.20	B	851011	FLOWING
W2-19-19-31-NW	WELL M4	REGINA PWED	592.59	GRD	?	A	LF	24.17	28.74	-0.00	+592.59	B	6210	FLOWING WHEN DRILLED
W2-19-19-31-NW	WELL M4	REGINA PWED	592.59	GRD	?	A	LF	24.17	28.74	-0.00	+592.59	B	851011	FLOWING
W2-19-19-31-SW	WELL #1	HILL 30	598.63	GRD	?	C	UF	4.57	13.72	-3.05	601.68	C	29	SEE P.97
W2-19-19-31-SW	WELL #2	HILL 30	594.97	GRD	?	C	UF	15.24	17.98	-5.79	600.76	C	29	SEE P.97
W2-19-19-32-NW	COUNTRY LANE FARMS	FFIB	617.22	GRD	?	C	LF	63.70	65.23	27.74	589.48	C	790724	
W2-19-20-05-04-NE	D.KLEIN	SRC	617.22	GRD	?	C	LF	47.85	49.38	22.25	594.97	C	7304	
W2-19-20-05-SE	T.G.DAVIES	FFIB	627.89	GRD	?	C	LF	63.70	65.23	28.96	598.93	C	730907	
W2-19-20-06-02-SW	E.K.WAGNER	SRC	609.60	GRD	?	C	LF	33.53	35.05	6.71	602.89	C	700522	
W2-19-20-06-09-SE	H.RITTER	SRC	618.74	GRD	?	C	LF	56.39	57.91	22.25	596.49	C	7004	
W2-19-20-10-04-NW	N.D.BOSWELL	FFIB	640.08	GRD	?	C	LF	58.83	60.35	38.10	601.98	C	751118	
W2-19-20-10-15-NE	WASCANA ARCH CLUB	SRC	652.27	GRD	?	C	LF	72.24	73.76	36.88	615.39	C	7210	
W2-19-20-19-12-SW	H.WAGNER	SRC	618.74	GRD	?	C	LF	55.17	56.69	40.23	578.51	C	7307	
W2-19-20-31-16-NE	E.K.WAGNER	SRC	632.46	GRD	?	C	LF	67.06	68.58	59.74	572.72	C	650802	WL AT TOP OF AQUIFER
W2-19-20-36-14-SW	R.W.INNES	SRC	615.70	GRD	?	C	LF	77.42	80.47	29.26	586.44	C	690601	
W2-20-16-22-06-NE	McKENZIE	SRC	573.02	GRD	?	C	E	53.34	54.86	22.86	550.16	C	740807	
W2-20-17-05-SW	DEPT PUBLIC WORKS	DOE	571.50	GRD	?	C	UF	21.64	27.13	10.67	560.83	C	590710	
W2-20-17-07-NE	POISSANT	DOE	571.50	GRD	?	C	UF	?	24.38	14.33	557.17	C	320607	OPEN HOLE
W2-20-17-08-SE	PR PRIDE MUSHROOM	DOE/FFIB	571.50	GRD	?	C	?	33.22	37.80	14.63	556.87	C	800106	
W2-20-17-13-NE	CITY OF REGINA	DOE	566.32	GRD	?	C	?	17.07	20.12	7.62	558.70	C	601004	
W2-20-17-16-NE	C.PETERSON	DOE	568.45	GRD	?	C	?	51.82	54.86	19.81	548.64	C	800524	
W2-20-17-16-NE	W.MEBS	DOE	571.50	GRD	?	C	?	46.33	48.16	19.20	552.30	C	640817	
W2-20-17-21-SE	RM OF SHERWOOD	DOE	576.00	GRD	?	C	?	39.62	42.67	17.98	558.02	C	640703	
W2-20-17-21-SW	WESTERN CLAY PROD	DOE	576.00	GRD	?	C	?	42.67	45.72	18.29	557.71	C	561006	

APPENDIX B - WATER LEVEL DATA

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	FM	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	WLV ACC	DATE YYMMDD	REMARKS
W2-20-17-22-NE	RCMP	DOE	573.02	GRD	?	C	IGS	49.38	53.95	12.50	560.53	C	590319	
W2-20-17-22-NE	RCMP OBS #1	MOLLARD 73	573.02	GRD	0.00	C	IGS	46.63	?	14.05	558.97	C	730403	
W2-20-17-22-NE	RCMP OBS #2	MOLLARD 73	573.02	GRD	0.09	C	IGS	49.38	52.43	14.14	558.88	C	730403	
W2-20-17-22-NE	RCMP PW3-73	MOLLARD 73	573.02	GRD	0.91	C	IGS	40.23	55.17	14.17	558.85	C	730330	MULTIPLE SCREENS
W2-20-17-23-NW	REGINA GOLF CLUB	DOE	569.98	GRD	?	C	IGS	26.21	29.87	9.14	560.83	C	6110	
W2-20-17-23-NW	SASK HOUSE REGINA	DOE	573.02	GRD	?	C	IGS	53.04	57.91	16.76	556.26	C	690707	
W2-20-17-24-NW	WELL R3	DOE	576.62	GRD	?	A	IGS	51.82	59.44	18.29	558.33	B	600822	SWL WHEN DRILLED
W2-20-17-24-NW	WELL R3	LISSEY 62	576.62	GRD	?	A	IGS	51.82	59.44	16.15	560.47	B	610309	1 OBS WELL
W2-20-17-26-NE	TH8-BR60	LISSEY 62	576.89	GRD	0.73	A	IGS	57.91	60.96	16.06	560.83	B	601011	2 OBS WELLS
W2-20-17-28-NW	INDUSTRIAL SCHOOL	WYNNE-ROB 12	573.02	GRD	?	C	UF	?	28.04	8.23	564.79	C	12	
W2-20-17-28-NW	INDUSTRIAL SCHOOL	DOE	571.50	GRD	?	C	UF	?	36.27	9.14	562.36	C	390830	OPEN HOLE
W2-20-17-29-NE	DOME PETROLEUM	DOE	572.5	GRD	?	C	UF	29.87	31.39	15.85	556.65	C	800908	
W2-20-17-29-SE	HYDRO GAS	DOE	577.29	GRD	?	C	UF	27.43	36.58	15.24	562.05	C	700828	
W2-20-17-29-SE	PROCOR REGINA	DOE	575.00	GRD	?	C	UF	22.86	24.38	16.15	558.85	C	740729	
W2-20-17-29-SE	PROCOR REGINA	DOE	575.00	GRD	?	C	UF	19.81	21.34	14.33	560.67	C	740730	
W2-20-17-29-SE	PROCOR REGINA	DOE	575.00	GRD	?	C	UF	27.43	28.96	17.07	557.93	C	740731	
W2-20-17-29-SW	COMINCO REGINA	DOE	575.00	GRD	?	C	UF	42.06	47.85	15.54	559.46	C	6404	
W2-20-17-29-SW	COMINCO REGINA	DOE	575.00	GRD	?	C	UF	53.34	60.96	17.37	557.63	C	6407	
W2-20-17-29-SW	COMINCO REGINA	DOE	575.00	GRD	?	C	UF	55.78	57.30	17.37	557.63	C	6407	
W2-20-17-32-15-NW	W4(R8-63)	DOE	574.55	GRD	0.00	C	UF	27.13	35.36	13.11	561.44	C	6112	DRILLED
W2-20-17-32-15-NW	W4(R8-63)	JACKSON 64	574.55	GRD	0.00	C	UF	27.13	35.36	16.00	558.55	C	630320	SEE APPENDIX B
W2-20-17-32-15-NW	W4(R8-63)	JACKSON 64	574.55	GRD	0.00	C	UF	27.13	35.36	13.03	561.52	C	631202	SEE APPENDIX B
W2-20-17-32-15-NW	W4(R8-63)	JACKSON 64	574.55	GRD	0.00	C	UF	27.13	35.36	13.00	561.55	C	640323	SEE APPENDIX B
W2-20-17-32-15-NW	W4(R8-63)	MLM 80	574.55	PHF	?	C	UF	27.13	35.36	18.59	555.96	C	80	
W2-20-17-32-16-NE	W3(R7-63)	DOE	574.24	GRD	0.00	C	UF	27.43	38.10	14.33	559.91	C	6202	DRILLED
W2-20-17-32-16-NE	W3(R7-63)	JACKSON 64	574.24	GRD	0.00	C	UF	27.43	38.10	14.23	560.02	C	631202	SEE APPENDIX B
W2-20-17-32-16-NE	W3(R7-63)	JACKSON 64	574.24	GRD	0.00	C	UF	27.43	38.10	14.44	559.80	C	640323	SEE APPENDIX B
W2-20-17-32-16-NE	W3(R7-63)	MLM 80	574.24	GRD	0.00	C	UF	27.43	38.10	18.29	555.96	C	80	
W2-20-17-32-NE	C OF REGINA HOLE #7	DOE	574.55	GRD	?	C	UF	28.65	33.22	14.94	559.61	C	6205	
W2-20-17-32-NE	O&T POULTRY	DOE	574.55	GRD	?	C	UF	35.66	37.19	16.76	557.79	C	670320	
W2-20-17-33-15-NW	W2(R6-63)	DOE	575.77	GRD	0.00	C	UF	?	?	15.24	560.53	C	6203	DRILLED
W2-20-17-33-15-NW	W2(R6-63)	JACKSON 64	575.77	GRD	0.00	C	UF	?	?	16.17	559.60	C	630926	SCREEN 32.2-36,39.3-46.6
W2-20-17-33-15-NW	W2(R6-63)	JACKSON 64	575.77	GRD	0.00	C	UF	?	?	15.37	560.40	C	640323	SCREEN 32.2-36,39.3-46.6
W2-20-17-33-16	TH8-B.I.61	LISSEY 62	575.25	CAS	?	A	UF	44.20	45.72	15.03	560.22	A	611206	3 OBS WELL
W2-20-17-33-16	TH8-B.I.61	JACKSON 64	575.25	CAS	?	A	UF	44.20	45.72	15.58	559.67	A	640302	
W2-20-17-33-16-NE	W1(R5-63)	DOE	575.16	GRD	0.76	C	UF	?	?	12.65	560.99	C	6303	DRILLED
W2-20-17-33-16-NE	W1(R5-63)	JACKSON 64	575.16	GRD	0.76	C	UF	?	?	12.82	560.82	C	631202	SCREEN 32-37.5,42.4-46M
W2-20-17-33-16-NE	W1(R5-63)	JACKSON 64	575.16	GRD	0.76	C	UF	?	?	12.78	560.86	C	640323	SCREEN 32-37.5,42.4-46M
W2-20-17-33-NW	TH10-B.I.61	LISSEY 62	575.55	CAS	1.04	A	UF	35.05	36.58	15.32	560.23	B	611116	4 OBS WELLS
W2-20-17-33-NW	TH10-B.I.61	LISSEY 62	575.55	CAS	1.04	A	UF	35.05	36.58	15.67	559.89	B	620508	
W2-20-17-34-SE	REGENT REALTY LTD	DOE	576.07	GRD	?	C	UF	38.71	40.23	18.90	557.17	C	640602	
W2-20-17-35-NW	R4	DOE	576.07	GRD	?	C	UF	31.70	40.84	15.85	560.22	C	610724	
W2-20-17-35-NW	R4	LISSEY 62	576.07	GRD	0.46	C	UF	31.39	40.84	16.58	559.49	C	6201	P.84
W2-20-17-35-NW	TH6-BR60	LISSEY 62	576.07	GRD	0.88	B	UF	38.10	41.15	16.79	559.28	B	600928	1 OBS WELL
W2-20-17-36-SE	KARELS OIL REFINERY	DOE	576.07	GRD	?	C	UF	?	41.45	12.19	563.88	C	320706	SEE DRILLERS LOG DOE
W2-20-17-36-SW	C OF REGINA HOLE#19	DOE	576.07	GRD	?	C	UF	28.04	32.61	15.85	560.22	C	6710	6.5" CASING
W2-20-17-36-SW	C OF REGINA HOLE#20	DOE	576.07	GRD	?	C	UF	31.39	32.92	16.15	559.92	C	671107	2" CASING

APPENDIX B - WATER LEVEL DATA

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	FM	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	WLV ACC	DATE YYMMDD	REMARKS
W2-20-17-36-SW	C OF REGINA HOLE#21	DOE	576.07	GRD	?	C	UF	29.57	32.61	15.85	560.22	C	6711	4" CASING
W2-20-17-36-SW	R7	DOE	571.50	GRD	?	C	UF	25.60	31.70	15.85	555.65	C	6802	DRILLED
W2-20-18-02	FORRESTER	WYNNE-ROB 12	579.12	GRD	?	C	UF		32.00	19.81	559.31	C	12	
W2-20-18-03	I.S.BELL	WYNNE-ROB 12	576.07	GRD	?	C	UF		30.78	19.20	556.87	C	12	
W2-20-18-04-NE	TH82-3	REGINA PWED	576.18	CAS	?	A	UF	46.63	52.12	20.19	555.99	A	831217	
W2-20-18-04-NE	WELL W5	REGINA PWED	576.18	CAS	?	C	UF	29.26	50.90	19.69	556.49	C	830517	DRILLED (SEE TH82-3)
W2-20-18-04-SE	G.PISCH	DOE/SRC	574.55	GRD	?	C	UF	33.53	36.58	11.28	563.27	C	670822	
W2-20-18-07-SW		MACKAY 1936	575.46	GRD	?	C	CM	?	12.19	11.28	564.18	C	35	
W2-20-18-08-NE		MACKAY 1936	576.38	GRD	?	C	UF	?	21.34	15.24	561.14	C	35	
W2-20-18-08-NE	TH98-BR60	LISSEY 62	575.16	GRD	0.43	B	UF	39.62	42.67	14.75	560.41	B	601027	1 OBS WELL
W2-20-18-09-NW		MACKAY 1936	576.07	GRD	?	C	CM	?	15.24	9.14	566.93	C	35	
W2-20-18-10-09-SW	H-13A, 1982	CLIFTON 85		GRD	1.20	A	UF	40.00	42.30		556.80	A	8411	
W2-20-18-10-09-SW	H-13B, 1982	CLIFTON 85		GRD	1.40	A	CM	18.20	20.20		565.20	B	8411	
W2-20-18-10-12-SW	H-24A, 1983	CLIFTON 85		GRD	0.63	A	UF	26.20	32.30		557.57	A	8411	
W2-20-18-10-12-SW	H-24B, 1983	CLIFTON 85		GRD	0.45	A	CM	13.71	19.81		562.64	A	8411	
W2-20-18-10-SW	BELL	WYNNE-ROB 12	579.12	GRD	?	C	UF	?	37.19	28.04	551.08	C	12	
W2-20-18-11-12-NE	H-22, 1983	CLIFTON 85		GRD	1.04	A	CM	18.30	24.40		566.15	A	8411	
W2-20-18-11-NE	E.GILCHRIST	DOE	594.36	GRD	?	C	E	78.33	79.86	36.58	557.78	C	630610	
W2-20-18-11-NE	FORRESTER	WYNNE-ROB 12	594.36	GRD	?	C	UF	?	41.15	25.91	568.45	C	12	
W2-20-18-12-12-SW	H-29, 1983	CLIFTON 85		GRD	?	A	CM	25.60	27.60	24.70	568.78	B	83	
W2-20-18-12-16-NW	SRC TESTHOLE	SRC	595.88	GRD	?	C	CM	?	?	26.21		C	7407	SEE TESTHOLE E-LOG
W2-20-18-12-NE	ALBERT ST RES R2	DOE	598.90	CAS	?	B	CM	32.31	35.36	27.43	571.47	C	600707	DRILLED
W2-20-18-12-NE	ALBERT ST RES R2	LISSEY 62	598.90	PHF	-2.67	A	CM	32.31	35.36	28.13	570.77	A	610912	3 OBS WELLS
W2-20-18-12-NE	ALBERT ST RES R2	LISSEY 62	598.90	PHF	-2.67	B	CM	32.31	35.36	28.16	570.74	B	6203	
W2-20-18-12-NE	ALBERT ST RES R2	MLM 80	598.90	PHF	-2.67	B	CM	32.31	35.36	28.35	570.56	B	80	
W2-20-18-12-NE	TH3-IWS-59	LISSEY 62	598.99	GRD	?	B	CM	31.70	34.75	27.25	571.74	B	591112	1 OBS WELL
W2-20-18-12-SE	R.ARMOUR	WYNNE-ROB 12	591.31	GRD	?	C	?	?	43.59	29.57	561.75	C	12	
W2-20-18-13	LIQUID CARBONIC	DOE	594.36	GRD	?	C	CM	34.14	39.62	27.43	566.93	C	591214	
W2-20-18-13	SOUTHERN STEEL	DOE	594.36	GRD	?	C	CM	32.31	33.53	22.56	571.80	C	6307	
W2-20-18-13-01-SW	CAL 501, IPSCO	CLIFTON 85	?	?	?	?	UF	?	?	?	558.79	A	8411	
W2-20-18-13-01-SW	CAL 502, IPSCO	CLIFTON 85	?	?	?	?	CM	?	?	?	570.05	A	8411	
W2-20-18-13-06-SE		MACKAY 1936	586.74	GRD	?	C	CM		24.38	21.95	564.79	C	35	
W2-20-18-13-06-SE	IPSCO	DOE	592.84	GRD	?	C	?	57.30	60.35	39.93	552.91	C	671010	M.HALL DRILLING 25IGPM
W2-20-18-13-06-SE	IPSCO PLANT SITE	SRC	592.84	GRD	?	C	CM	?	?	28.04	565.40	C	671010	SEE E-LOG
W2-20-18-13-SE	IPSCO	DOE	594.36	GRD	?	C	CM	26.21	31.70	25.60	568.76	C	6005	
W2-20-18-13-SW	NATIVE AUTO IND	DOE	594.36	GRD	?	C	?	51.21	52.73	27.74	566.62	C	7311	M.HALL DRILLING 60IGPM
W2-20-18-13-SW	SHAW PROTECTION	DOE	594.36	GRD	?	C	CM	29.26	34.75	19.51	574.85	C	6104	
W2-20-18-14-03-NE	H-4, 1982	CLIFTON 85		GRD	1.20	A	CM	?	27.70	27.00	567.35	B	82	
W2-20-18-15-12-NW	SRC REGINA 530	SRC RECORDS	589.79	CAS	?	C	UF	37.31	38.56	32.58	557.20	C	7802	OBSERVATION WELL
W2-20-18-15-12-NW	SRC REGINA 530	SRC RECORDS	589.79	CAS	?	C	UF	37.31	38.56	33.22	556.56	C	7902	OBSERVATION WELL
W2-20-18-15-12-NW	SRC REGINA 530	SRC RECORDS	589.79	CAS	?	C	UF	37.31	38.56	33.44	556.35	C	8002	OBSERVATION WELL
W2-20-18-15-12-NW	SRC REGINA 530	SRC RECORDS	589.79	CAS	?	C	UF	37.31	38.56	34.47	555.32	C	8102	OBSERVATION WELL
W2-20-18-15-12-NW	SRC REGINA 530	SRC RECORDS	589.79	CAS	?	C	UF	37.31	38.56	33.77	556.02	C	8203	OBSERVATION WELL
W2-20-18-15-12-NW	SRC REGINA 530	SRC RECORDS	589.79	CAS	?	C	UF	37.31	38.56	33.80	555.99	C	8302	OBSERVATION WELL
W2-20-18-15-12-NW	SRC REGINA 530	SRC RECORDS	589.79	CAS	?	C	UF	37.31	38.56	33.77	556.02	C	8402	OBSERVATION WELL
W2-20-18-15-12-NW	SRC REGINA 530	SRC RECORDS	589.79	CAS	?	C	UF	37.31	38.56	34.66	555.13	C	8502	OBSERVATION WELL
W2-20-18-16-16-NE	DOE TEST HOLE	SRC	594.36	GRD	?	C	CM	?	?	30.48	563.88	C	75	SWL FROM E-LOG

APPENDIX B - WATER LEVEL DATA

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	FM	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	WLV ACC	DATE YYMMDD	REMARKS
W2-20-18-16-16-SE	I.MORGAN	DOE/FFIB	586.74	GRD	?	C	UF	44.20	45.72	29.00	557.74	C	761027	DD 27.4M AT 50 IGPM
W2-20-18-16-NE	J.JONES	DOE	586.74	GRD	?	C	UF	37.19	38.10	31.70	555.04	C	600515	DD 3.7M AFTER 4HRS 2IGPM
W2-20-18-22-SE	A.MACDOUGALL	DOE	585.22	GRD	?	C	?	58.83	60.35	14.02	571.20	C	6903	
W2-20-18-24-SE	BOTKINS CONST	DOE	585.22	GRD	?	C	?	51.82	57.61	28.04	557.17	C	681128	
W2-20-18-24-SE	L.M.IRIVIN	DOE	583.66	GRD	?	C	?	27.43	28.96	10.97	572.69	C	650908	
W2-20-18-32-NW	M.PEARCE	DOE/FFIB	563.88	GRD	?	C	?	29.87	31.39	3.66	560.22	C	801110	
W2-20-18-32-SE	DNR CONDIE	DOE	563.88	GRD	?	C	?	13.72	15.24	3.05	560.83	C	670418	
W2-20-18-32-SE	DNR CONDIE 2	DOE	571.50	GRD	?	C	?	15.85	17.37	7.62	563.88	C	700727	
W2-20-18-32-SE	DNR CONDIE 3	DOE	571.50	GRD	?	C	?	29.26	30.48	5.79	565.71	C	700728	
W2-20-18-33-SE	M.PEARCE	DOE	579.12	GRD	?	C	?	29.87	31.39	3.66	575.46	C	801118	
W2-20-20-16-02-SE	W.SMALL	SRC	573.02	GRD	?	C	E	128.63	131.67	79.55	493.47	C	7310	
W2-20-20-21-NE	PUMP WELL	LISSEY 62	514.20	GRD	0.61	C	E	66.45	69.49	19.35	494.84	C	601202	
W2-20-20-21-NE	TH17-BR60	LISSEY 62	512.06	GRD	0.15	C	E	63.70	65.23	17.34	494.72	C	601202	
W2-20-20-22-06-NE	W.M.CATLEY	SRC	582.17	GRD	?	C	E	130.76	132.28	85.34	496.82	C	730719	
W2-20-20-24-13-NW	R.G.HALL	SRC	600.46	GRD	?	C	UF	49.38	52.43	18.29	582.17	C	7310	
W2-20-20-27-04	E.A.PODEN	SRC	579.12	GRD	?	C	E	124.36	127.41	83.82	495.30	C	690716	
W2-21-16-02-NE	D.GANSHORN	FFIB	583.69	GRD	?	C	LF	45.11	48.16	19.20	564.49	C	750612	
W2-21-16-03-NW	W.GANSHORN	FFIB	582.17	GRD	?	C	LF	30.78	32.31	23.77	558.39	C	760921	
W2-21-16-12-NW	G.SELBY	FFIB	582.17	GRD	?	C	LF	52.12	53.64	24.38	557.78	C	810812	
W2-21-16-24-SW	V.BARIL	FFIB	579.00	GRD	?	C	LF	29.87	31.39	22.86	556.14	C	770309	
W2-21-16-25-NE	SPC OBS #1	MOLLARD 65	574.55	CAS	?	C	UF	33.53	44.38	13.59	560.95	C	650309	SCR 33.5-36.2,42.3-44.4
W2-21-16-25-NE	SPC OBS #2	MOLLARD 65/SRC	574.55	CAS	?	C	UF	33.65	44.20	14.03	560.52	C	650309	SCR 33.5-36,42.7-44.2
W2-21-16-25-NE	SPC PUMP WELL	MOLLARD 65	574.55	CAS	?	C	UF	31.09	45.11	13.89	560.66	C	650309	SCR 44.8-37.8,42.1-45.1
W2-21-17-14-06-SE	W.FARLEY	SRC	569.98	GRD	?	C	LF	44.81	47.85	16.46	553.52	C	670712	
W2-21-18-14-14-NE	H.MARTIN	SRC	582.17	GRD	?	C	?	64.62	66.14	24.38	557.78	C	681218	
W2-21-18-24-NW	E.H.GHERASIM	FFIB	583.69	GRD	0.31	C	CM	28.96	30.48	14.63	569.06	C	7306	
W2-21-18-26-SE	C.G.ENGLISH	FFIB	579.12	GRD	?	C	CM	16.15	17.68	13.41	565.71	C	7308	
W2-21-18-36-13-SW	V.HINTON	FFIB	563.88	GRD	?	C	LF	35.05	36.58	9.14	554.74	C	750610	
W2-21-21-07-SE	UNITED CHURCH	DOE	548.64	GRD	?	C	?	?	?	20.42	528.22	C	600630	OPEN HOLE
W2-21-21-07-SW	BUENA VISTA	DOE	541.02	GRD	?	C	?	64.92	67.97	30.48	510.54	C	820730	
W2-21-21-07-SW	VILLAGE OF LUMSDEN	DOE	548.64	GRD	?	C	?	?	?	20.42	528.22	C	670820	OPEN HOLE
W2-21-21-08-NW	KANNATA SILTON	DOE	533.40	GRD	?	C	?	43.89	48.46	+12.19	545.59	C	810603	FLOWING WELL
W2-21-21-08-SE	BOSCO SOCIETY	DOE	548.64	GRD	?	C	?	121.92	124.96	84.73	463.91	C	800927	
W2-21-21-14-NE	ALBERT RUMPEL	DOE	556.26	GRD	?	C	?	42.67	44.2	15.24	541.02	C	801112	

APPENDIX C

YEARLY GROUNDWATER WITHDRAWALS

TABLE C-1 YEARLY GROUNDWATER WITHDRAWALS FROM WELL FIELDS OR AQUIFERS

Notes

1. All withdrawals are in units of dam^3 (cubic decameters or thousands of cubic meters).
2. Blanks in the tables mean that no information is available. Where withdrawals are known to be zero they are entered as such.
3. Source of data: The name and date sources refer to reports listed in the references section of the main report. DOE/SWC records refer to records collected and held by the Saskatchewan Department of the Environment (DOE) or the Saskatchewan Water Corporation (SWC). City data refers to records held by the Public Works and Engineering Department of the City of Regina.
4. Estimated withdrawals are indicated by question marks.
5. Data from the report by Ball, 1978 were calculated by taking total water consumption minus water from Buffalo Pound. Note that in the years where Ball's data overlap with DOE/SWC records there are large discrepancies. These may be due to the fact that Ball's total consumption data presumably do not include unmetered consumption and leakage losses.
6. All detailed data for well field withdrawals are based on total running hours for each well and the rated production capacity of each well. There do not appear to be any metered well withdrawal data.

TABLE C-1 YEARLY GROUNDWATER WITHDRAWALS FROM WELL FIELDS OR AQUIFERS (DAM3)

YEAR	BOGGY CREEK CITY WELLS	MALLORY SPRINGS CITY WELLS	MOUND SPRINGS CITY WELLS	CONDIE AQUIFER CITY WELL R-2	REGINA AQUIFER CITY WELLS	REGINA AQUIFER PRIVATE WELLS	REGINA AQUIFER WELLS TOTAL	TOTAL GROUNDWATER FROM CITY WELLS	SOURCE OF DATA
1908	747	0	0	0	0			747	BALL 1978
1909		0	0	0	0				
1910		0	0	0	0				
1911	1659	0	0	0	0			1659	BALL 1978
1912		0	0	0	0				
1913	2199	0	0	0	0			2199	BALL 1978
1914	?	0	0	0	0				
1915	3537	0	0	0	0			3537	BALL 1978
1916	3996	0	0	0	0			3996	BALL 1978
1917	4191	0	0	0	0			4191	BALL 1978
1918	3960	0	0	0	0			3960	BALL 1978
1919	3414	0	0	0	0			3414	BALL 1978
1920	3941	0	0	0	0			3941	BALL 1978
1921	4187	0	0	0	0			4187	BALL 1978
1922	4328	0	0	0	0			4328	BALL 1978
1923	4541	0	0	0	0			4541	BALL 1978
1924	4464	0	0	0	0			4464	BALL 1978
1925	4532	0	0	0	0			4532	BALL 1978
1926	4817	0	0	0	0			4817	BALL 1978
1927	4897	0	0	0	0			4897	BALL 1978
1928			0	0	0			5126	BALL 1978
1929			0	0	0			5980	BALL 1978
1930	4168?	1012?	0	0		1660?	2042?	5562? 6319	HILL 1930 BALL 1978

TABLE C-1 YEARLY GROUNDWATER WITHDRAWALS FROM WELL FIELDS OR AQUIFERS (DAM3)

YEAR	BOGGY CREEK CITY WELLS	MALLORY SPRINGS CITY WELLS	MOUND SPRINGS CITY WELLS	CONDIE AQUIFER CITY WELL R-2	REGINA AQUIFER CITY WELLS	REGINA AQUIFER PRIVATE WELLS	REGINA AQUIFER WELLS TOTAL	TOTAL GROUNDWATER FROM CITY WELLS	SOURCE OF DATA
	3105							6319	BECKIE (CITY DATA)
1931				0				6002	BALL 1978
	3091							6002	BECKIE (CITY DATA)
1932				0				6998	BALL 1978
1933				0				6673	BALL 1978
1934				0				5839	BALL 1978
1935				0				5970	BALL 1978
1936				0				6203	BALL 1978
	3202	1179	629					6203	BECKIE (CITY DATA)
1937				0				6640	BALL 1978
	3469	1292	573					6640	BECKIE (CITY DATA)
1938				0				6968	BALL 1978
1939				0				6546	BALL 1978
1940				0				6627	BALL 1978
1941				0				7229	BALL 1978
1942				0				7203	BALL 1978
1943				0				7659	BALL 1978
1944				0				7950	BALL 1978
1945				0				7710	BALL 1978
1946				0				7917	BALL 1978
1947				0				7646	BALL 1978
1948				0				8237	BALL 1978
1949				0				9117	BALL 1978
1950				0				8835	BALL 1978
1951				0				8529	BALL 1978

TABLE C-1 YEARLY GROUNDWATER WITHDRAWALS FROM WELL FIELDS OR AQUIFERS (DAM3)

YEAR	BOGGY CREEK CITY WELLS	MALLORY SPRINGS CITY WELLS	MOUND SPRINGS CITY WELLS	CONDIE AQUIFER CITY WELL R-2	REGINA AQUIFER CITY WELLS	REGINA AQUIFER PRIVATE WELLS	REGINA AQUIFER WELLS TOTAL	TOTAL GROUNDWATER FROM CITY WELLS	SOURCE OF DATA
1952				0				8719	BALL 1978
1953				0				9292	BALL 1978
1954				0				9369	BALL 1978
1955				0				9640	BALL 1978
1956				0				10550	BALL 1978
1957				0				11090	BALL 1978
1958				0				10870	BALL 1978
1959				0				9370	BALL 1978
	6000?	1000?	800?						LOCKWOOD 1961
1960				0		5000?			MOLLARD 1960
								9230	BALL 1978
1961								8000	BALL 1978
1962								8550	BALL 1978
1963								9140	BALL 1978
1964								10590	BALL 1978
1965								11100	BALL 1978
1966								11910	BALL 1978
	5000?	1200?	2500?			6600?		12000?	MOLLARD 1966
1967								14460	BALL 1978
						1803			DOE/SWC RECORDS
								3350	BALL 1978
1969	3209	176	1131	147	1318	2207	3525	5981 5318	DOE/SWC RECORDS BALL 1978
1970	2329	0	1140	69	592	2494	3086	4130 4910	DOE/SWC RECORDS BALL 1978
1971	2843	0	2062	88	719	2957	3676	5712 5680	DOE/SWC RECORDS BALL 1978
1972	2743	322	1372	44	679	2800	3479	5160	DOE/SWC RECORDS

TABLE C-1 YEARLY GROUNDWATER WITHDRAWALS FROM WELL FIELDS OR AQUIFERS (DAM3)

YEAR	BOGGY CREEK CITY WELLS	MALLORY SPRINGS CITY WELLS	MOUND SPRINGS CITY WELLS	CONDIE AQUIFER CITY WELL R-2	REGINA AQUIFER CITY WELLS	REGINA AQUIFER PRIVATE WELLS	REGINA AQUIFER WELLS TOTAL	TOTAL GROUNDWATER FROM CITY WELLS	SOURCE OF DATA
								4820	BALL 1978
1973	3446	216	1717	109	299	2538	2837	5787	DOE/SWC RECORDS
								3770	BALL 1978
1974	3901	155	1605	255	632	2602	3234	6548	DOE/SWC RECORDS
								3050	BALL 1978
1975	4204	68	2349	331	743	2247	2990	7695	DOE/SWC RECORDS
								6360	BALL 1978
1976	5244	2	2062	603	855	1367	2222	8766	DOE/SWC RECORDS
								7860	BALL 1978
1977	3899	0	2267	517	1597	1397	2994	8280	DOE/SWC RECORDS
	3872	0	2202	362	1826			8262	CITY DATA
								7820	BALL 1978
1978	5050	0	2153	661	1738	1435	3173	9602	DOE/SWC RECORDS
	5021	0	2121	476	1892			9510	CITY DATA
1979	4709	577	2177	492	3381	1329	4710	11336	DOE/SWC RECORDS
	4720	579	2182	493	3391			11365	CITY DATA
1980	4791	1044	2529	476	5307	1372	6679	14147	DOE/SWC RECORDS
	4803	1047	2336	478	5321			13985	CITY DATA
1981	3918	504	2211	163	3057	1102	4159	9853	DOE/SWC RECORDS
	4015	506	2218	163	3069			9971	CITY DATA
1982	4378	485	1684	125	3133	1172	4305	9805	DOE/SWC RECORDS
	3981	486	1575	111	3123			9276	CITY DATA
1983						1141			DOE/SWC RECORDS
	4846	528	1804	120	2856			10154	CITY DATA
1984						1164			DOE/SWC RECORDS
	5543	696	2016	159	4189			12603	CITY DATA

TABLE C-2 YEARLY WITHDRAWALS FROM PRIVATE WELLS

Notes

1. The source of these data are the records held by the Saskatchewan Water Corporation (S.W.C.).
2. WR file refers to the file number assigned to the well or consumer by S.W.C. records.
3. The data do not include minor withdrawal by small consumers.
4. Carling Breweries ceased operations in 1980: Imperial oil Refineries Ltd. ceased operations in 1975: Genstar was Inland Cement until 1982.
5. Total withdrawals appear to be based on meter readings, taken monthly.

TABLE C-2 YEARLY WITHDRAWALS FROM PRIVATE WELLS

NAME	WR FILE	DESCRIPTION OF WELL	WELL LOCATION	ANNUAL WITHDRAWAL (DAM3 PER YEAR)									
				1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PRODUCER ABATTOIR													
CARLING BREWERIES		2 WELLS @ -198'	W2-19-17-30-NW	133.3	0	0	0	0					
DAD'S COOKIES		WELL-83'	W2-18-17-24-SW										
SILVERWOOD DAIRIES		WELL-187'	W2-19-17-19-NW										
IMPERIAL OIL ENT LTD	403	WELL #18-112'	W2-19-17-32-NW	0	0	0	0	0					
GENSTAR CEMENT	369	WELL-97'	W2-19-18-03-NW	212.2	167.8	145.6	170.3	171.5					
CONSUMERS CO-OP REF	413	WELL #3-110'	W2-19-18-05-SE										
CONSUMERS CO-OP REF	415	WELL #5-147'	W2-19-18-05-SE	345.5	444.2	471.4	573.8	525.7					
CONSUMERS CO-OP REF	416	WELL #6-130'	W2-19-18-05-SE	104.9	35.8	51.8	44.4	60.5					
CONSUMERS CO-OP REF	417	WELL #7-125'	W2-19-18-05-SE										
CONSUMERS CO-OP REF	417	WELL #9	W2-19-18-05-SE	575	454.1	503	352.9	406					
WESTERN CLAY PROD		WELL-150'	W2-20-17-21-SW	1.2									
COMINCO LTD	234	WELL-207'	W2-20-17-29-SW										
IPSCO PIPE MILL			W2-20-18-13-SE										
			TOTAL	1372.1	1101.9	1171.8	1141.4	1163.7					

TABLE C-2 YEARLY WITHDRAWALS FROM PRIVATE WELLS

NAME	WR FILE	DESCRIPTION OF WELL	WELL LOCATION	ANNUAL WITDRAWAL (DAM3 PER YEAR)									
				1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
PRODUCER ABATTOIR				0.2	0.2	0.2	0.1						
CARLING BREWERIES		2 WELLS @ -198'	W2-19-17-30-NW	166.6	196.2	145.6	143.1	172.8	178.9	160.4	171.5	155.5	140.7
DAD'S COOKIES		WELL-83'	W2-18-17-24-SW		2.5	2.5							
SILVERWOOD DAIRIES		WELL-187'	W2-19-17-19-NW				16	17.3	17.3				
IMPERIAL OIL ENT LTD	403	WELL #18-112'	W2-19-17-32-NW	1359.9	1648.6	1617.8	1337.7	1132.8	1046.4	0	0	0	0
GENSTAR CEMENT	369	WELL-97'	W2-19-18-03-NW	50.6	145.6	100	102.4	127.1	124.6	107.4	117.2	140.7	178.9
CONSUMERS CO-OP REF	413	WELL #3-110'	W2-19-18-05-SE	911.9									
CONSUMERS CO-OP REF	415	WELL #5-147'	W2-19-18-05-SE		504.7	529.4	545	730.5	625.6	649.1	618.2	644.1	417.1
CONSUMERS CO-OP REF	416	WELL #6-130'	W2-19-18-05-SE		212.2	88.8	132	418.1	75.3	49.4	2.4		17.3
CONSUMERS CO-OP REF	417	WELL #7-125'	W2-19-18-05-SE		244.3	313.4	257.9	1.2	156.7	154.3	45.7		
CONSUMERS CO-OP REF	417	WELL #9	W2-19-18-05-SE						19.7	244.3	386.2	464	573.8
WESTERN CLAY PROD		WELL-150'	W2-20-17-21-SW	1.2	2.5	2.5	3.7	2.5	2.5	2.5	55.5	30.9	1.2
COMINCO LTD	234	WELL-207'	W2-20-17-29-SW	2.5									
IPSCO PIPE MILL			W2-20-18-13-SE	0.6									
			TOTAL	2493.5	2956.8	2800.2	2537.9	2602.3	2247	1367.4	1396.7	1435.2	1329

TABLE C-2 YEARLY WITHDRAWALS FROM PRIVATE WELLS

NAME	WR FILE	DESCRIPTION OF WELL	WELL LOCATION	ANNUAL WITHDRAWAL (DAM3 PER YEAR) 1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
PRODUCER ABATTOIR												0.2	0.2
CARLING BREWERIES		2 WELLS @ -198'	W2-19-17-30-NW									123.4	160.4
DAD'S COOKIES		WELL-83'	W2-18-17-24-SW										
SILVERWOOD DAIRIES		WELL-187'	W2-19-17-19-NW										
IMPERIAL OIL ENT LTD	403	WELL #18-112'	W2-19-17-32-NW									1081	1364.8
GENSTAR CEMENT	369	WELL-97'	W2-19-18-03-NW									38.3	43.2
CONSUMERS CO-OP REF	413	WELL #3-110'	W2-19-18-05-SE									519.5	629.3
CONSUMERS CO-OP REF	415	WELL #5-147'	W2-19-18-05-SE										
CONSUMERS CO-OP REF	416	WELL #6-130'	W2-19-18-05-SE										
CONSUMERS CO-OP REF	417	WELL #7-125'	W2-19-18-05-SE										
CONSUMERS CO-OP REF	417	WELL #9	W2-19-18-05-SE										
WESTERN CLAY PROD		WELL-150'	W2-20-17-21-SW									0.6	0.6
COMINCO LTD	234	WELL-207'	W2-20-17-29-SW									38.3	6.2
IPSCO PIPE MILL			W2-20-18-13-SE									1.5	3.2
			TOTAL									1802.8	2207.9

APPENDIX D

WATER QUALITY DATA

TABLE D-1 WATER QUALITY DATA

Notes

All presently available chemical analyses of groundwater in the Regina area have been tabulated and are arranged according to land location in Table D-1. This Table only includes those analyses which have an error in the ionic balance of less than five percent. Based on the present knowledge, the Table also indicates from which aquifer zone the sample was taken. The source of the water quality data is provided as well as the well or piezometer name. The references are listed in Section 10 of this report.

Abbreviations

uS/cm	means electrical conductivity at 25 degrees Celcius
N/D	means aquifer zone not determined
Condie	means Condie Aquifer
U.FL.	means Upper Floral Sand and Gravel aquifer zones
L.FL.	means Lower Floral Sand and Gravel aquifer zones
IGS	means Interglacial Sediments aquifer zone
Empress	means aquifer zone formed by Empress Group sediments
(1)	means electrical conductivity values available at ambient groundwater temperatures but not at 25 degrees Celcius

TABLE D - 1 WATER QUALITY DATA IN THE REGINA AREA

LAND LOCATION XX-XX-XX-XX-XX-XX	DATE YYMMDD	WELL NAME	WELL DEPTH M	AQUI-FER	PH	CA MG/L	MG MG/L	NA MG/L	K MG/L	FE MG/L	MN MG/L	CO3 MG/L	HCO3 MG/L	SO4 MG/L	CL MG/L	NO3 -NO3 MG/L	PO4 MG/L	F MG/L	COND. uS/CM	SUM OF IONS MG/L	T.H. MG/L	T.A. MG/L	REFERENCE
W2-15-20-07- -NW			3.7	N/D	7.90	69	48	2	12.0				458	11	4	7.0				611	370	376	RUTHERFORD,1967
W2-15-20-11- -NW			3.7	N/D	7.82	211	90	25	16.0				696	274	59	60.0				1431	898	571	RUTHERFORD,1967
W2-15-20-16- -NW			91.4	N/D	7.35	194	73	207	8.0				487	825	16					1810	785	400	RUTHERFORD,1967
W2-15-20-16-15-NE	750212		92.0	N/D	7.35	200	73	176	11.0	6.80	1.03		482	789	7	0.1	0.08	0.56	1930	1747	800	395	SRC
W2-15-20-21-03-SE	750212		91.4	N/D	7.22	235	83	187	11.0	14.50	0.89		408	909	7	0.8	0.03	0.42	2100	1937	926	400	SRC
W2-16-18-28- -NE			4.9	N/D		844	1023	583					458	8032	85					11025	6324	375	RUTHERFORD,1967
W2-16-18-28-09-SE	760919	MCLEAN	7.6	N/D	7.80	228	683	264	11.0	5.40	0.22		497	3470	11	9.0	0.27	1.05	4330	5180	3370	407	SRC
W2-16-19-08-14-SE	750212		60.4	N/D	7.32	133	48	72	4.0	3.09	1.57		519	374	<1	0.1	0.06	0.52	1150	1136	611	425	SRC
W2-16-19-20-15-NE	750212		96.3	N/D	7.19	312	151	122	11.0	30.60	0.49		616	1126	22	0.9		0.25	2210	2392	1400	505	SRC
W2-16-20-12- -NE			19.9	N/D	7.52	274	120	53	10.0				595	755	8					1815	1179	486	RUTHERFORD,1967
W2-16-20-31- -SE			1.8	N/D		100	115	232					519	754	15					1735	725	425	RUTHERFORD,1967
W2-17-15-26-03-SW	680627	LAJORD	4.9	N/D	6.95	113	67	237	9.0	1.24			401	708	28	NIL	NIL		1700	1564	731	329	SRC
W2-17-17-18- -NE			60.4	N/D		100	46	353					610	632	35					1776	439	500	RUTHERFORD,1967
W2-17-17-20- -NW			54.9	N/D	7.65	166	84	411	9.0				610	1020	54					2354	761	500	RUTHERFORD,1967
W2-17-17-21- -NE			27.4	N/D	7.52	290	92	310	9.0				755	1050	54					2560	1104	619	RUTHERFORD,1967
W2-17-17-22- -NE			15.8	N/D	7.80	138	29	115	5.0				555	296	13					1151	464	405	RUTHERFORD,1967
W2-17-17-25- -NE			40.2	N/D	7.92	179	94	70	7.0				665	402	10					1427	835	545	RUTHERFORD,1967
W2-17-17-33- -SE			12.2	N/D	7.72	172	144	90	8.0				437	810	25	20.0				1706	1023	358	RUTHERFORD,1967
W2-17-18-01- -SW			18.3	N/D		272	239	962					531	3125	45					5174	1664	435	RUTHERFORD,1967
W2-17-18-02- -SE			67.1	N/D	7.50	230	122	172	10.0				682	810	16					2042	1078	559	RUTHERFORD,1967
W2-17-19-02- -SW			7.6	N/D		86	163	371					525	1133	59					2337	885	430	RUTHERFORD,1967
W2-17-19-14-15-NW	750212		108.8	L.FL.	6.98	352	165	171	12.0	39.10	0.63		647	1370	<1	0.8	<0.01	0.41	2750	2758	1556	453	SRC
W2-17-19-30- -NE			14.3	N/D		522	252	51					293	2100	24					3242	2344	240	RUTHERFORD,1967
W2-17-19-34- -NE			30.5	N/D	7.95	240	144	85	6.0				625	840	16					1956	1193	512	RUTHERFORD,1967
W2-17-19-34- -SE			15.2	N/D	7.70	251	121	63	8.0				523	770	37					1773	1126	429	RUTHERFORD,1967
W2-17-20-14- -NW			64.6	N/D	7.50	249	134	149	6.0				742	830	21					2131	1174	608	RUTHERFORD,1967
W2-17-20-22- -NE			9.1	N/D	7.82	181	219	135	5.0				692	645	20					1897	1354	567	RUTHERFORD,1967
W2-17-20-28- -SE			18.3	N/D	7.90	169	137	37	9.0				576	587	58	36.0				1609	987	472	RUTHERFORD,1967
W2-18-17-04- -NE			12.2	N/D		50	67	992					604	1682	222					3617	403	495	RUTHERFORD,1967
W2-18-17-21-13-NW	750212		15.8	CONDIE	7.38	182	66	57	7.0	2.20	0.94		416	472	14	0.2	0.03	0.25	1360	1218	725	341	SRC
W2-18-17-23- -SE			9.1	CONDIE	8.05	156	126	53	10.0				389	275	65	418.0				1492	909	319	RUTHERFORD,1967
W2-18-17-26-14-SE	770314	OBS. #3	16.2	CONDIE	8.00	62	84	57		1.60	0.54		398	300	12	<1					500	326	BECKIE, 1977
W2-18-17-26-14-SE	770307	OBS. #3	16.2	CONDIE	8.00	69	60	152		14.00	0.10		500	300	12				1120	1107	420	410	BECKIE,1977
W2-18-17-29-13-NW	850318	PW1-85	54.0	U.FL.	7.30	93	37	34		0.10	0.92		350	136	6	1.0				658	384	287	BECKIE,1985
W2-18-17-29-13-NW	850300	OBS.1-85	55.2	U.FL.	7.60	80	41	41		3.90	0.77		368	160	8	1.0				704	368	301	BECKIE, 1985
W2-18-17-29-13-NW	850319	PW1-85	54.0	U.FL.	7.30	85	42	35		0.10	0.97		357	140	6	1.0				667	384	293	BECKIE, 1985
W2-18-17-30-12-SW	750210		51.7	U.FL.	7.37	99	45	39	5.0	4.70	0.91		398	184	<1	0.1	<0.01	0.50	885	776	431	326	SRC
W2-18-17-33-09-SE	840000	OBS.#4-84	16.8	CONDIE	7.70	85	24	30		3.70	0.20		312	118	12	<1			680	585	312	256	BECKIE, 1984
W2-18-17-33-14-SW	840000	OBS.#1-84	12.2	CONDIE	7.50	91	24	9		3.40	<0.01		284	60	18	78.0			585	567	328	233	BECKIE, 1984
W2-18-17-33-15-SW	840000	OBS.#3-84	17.1	CONDIE	7.70	106	30	14		2.00	0.35		170	106	28	<1			740	456	388	170	BECKIE, 1984
W2-18-17-33-16-NW	840000	OBS.#5-84	15.9	CONDIE	7.70	120	42	45		0.80	0.51		290	280	24	<1			975	802	472	238	BECKIE, 1984
W2-18-18-07- -NE	840724	REG. BC-6	68.9	U.FL.	7.30	117	57	33		0.40	0.80		442	244	6	<1				900	528	362	CITY OF REGINA
W2-18-18-07- -NE	660000	REG. P60	57.9	U.FL.	7.30	169	74	50	8.0		1.80		499	380	7					1189	703	409	MOLLARD, 1966
W2-18-18-07- -NE	800600	REG. BC-5	57.9	U.FL.	7.50	138	78	55		0.90	0.63		490	390	4	<1				1157	664	402	AESL, 1981
W2-18-19-07- -NE	840724	REG. BC-5	57.9	U.FL.	7.70	166	79	50		0.70	0.98		515	408	4	<1				1274	740	422	CITY OF REGINA
W2-18-18-07- -NE	660000	REG. P60	57.9	U.FL.	7.70	153	71	48	8.0	1.50			494	358	8					1132	694	397	MOLLARD, 1966
W2-18-18-07- -NE	800600	REG. BC-5	57.9	U.FL.	7.40	147	79	54		0.30	0.92		504	392	2	<1				1179	692	413	AESL, 1981
W2-18-18-07- -NE	830728	REG. BC-5	57.9	U.FL.	7.30	162	77	56		0.70	0.86		516	392	8	<1				1213	720	423	CITY OF REGINA
W2-18-18-07- -NE	800300	REG. BC-5	57.9	U.FL.	7.50	139	79	51		0.80	0.89		522	344	2	<1				1139	672	428	CITY OF REGINA
W2-18-18-07- -NE	830728	REG. BC-6	68.9	U.FL.	7.40	115	55	35		0.30	0.69		432	218	4	<1				860	516	354	CITY OF REGINA
W2-18-18-10-16-NE	770510	OBS. #6	23.5	U.FL.	8.20	34	41	11		1.50	0.01		273	40	4					405	252	224	BECKIE,1977

TABLE D - 1 WATER QUALITY DATA IN THE REGINA AREA

LAND LOCATION XX-XX-XX-XX-XX-XX	DATE YYMMDD	WELL NAME	WELL DEPTH M	AQUIFER	PH	CA MG/L	MG MG/L	NA MG/L	K MG/L	FE MG/L	MN MG/L	CO3 MG/L	HCO3 MG/L	SO4 MG/L	CL MG/L	NO3 -NO3 MG/L	PO4 MG/L	F MG/L	COND. uS/CM	SUM OF IONS MG/L	T.H. MG/L	T.A. MG/L	REFERENCE
W2-18-18-10-16-NE	770531	T.P.W #3	23.0	U.FL.	8.20	24	51	10		0.40	0.91		307	36	<2					429	270	252	BECKIE,1977
W2-18-18-21-14-NE	750212		53.6	U.FL.	7.20	163	81	41	7.0	3.78	1.50		569	357	4	0.4	<0.01	0.42	1250	1228	737	466	SRC
W2-18-18-31-04-SE	750210		46.6	U.FL.	7.52	153	93	61	7.0	1.40	1.83		571	417	7	0.2	<0.01	0.40	1460	1313	764	468	SRC
W2-18-19-31-14-SE	750211		64.0	L.FL.	7.06	211	130	76	10.0	0.74	1.80		742	583	17	25.7	<0.01	0.38	1740	1798	1060	608	SRC
W2-18-20-22- -SE			35.1	N/D	7.55	477	257	125	12.0				630	1911	19					3431	2251	516	RUTHERFORD,1967
W2-19-16-33- -NE			14.9	N/D		130	74	441					586	952	80					2263	629	480	RUTHERFORD,1967
W2-19-16-34-13-NW	750210		20.1	U.FL.	7.42	124	80	481	12.0	15.40	0.24		447	1055	70	0.4	0.15	0.24	2640	2465	638	530	SRC
W2-19-17-01-02-NW	750210		30.5	U.FL.	7.29	121	59	421	8.0	10.30	0.17		620	857	63	11.5	0.08	0.38	2440	2178	549	509	SRC
W2-19-17-01-03-NE	750212		25.0	U.FL.	7.34	122	56	429	9.0	1.00	0.15		633	857	59	0.1	0.10	0.35	2310	2167	534	519	SRC
W2-19-17-01-13-NW	750212		17.4	U.FL.	7.68	117	60	423	10.0	0.60	4.37		654	839	71	0.2	0.09	0.34	2470	2180	538	536	SRC
W2-19-17-24-09-SE	750210		78.9	EMP	7.38	157	69	372	10.0	13.10	1.06		666	863	59	0.2	<0.01	0.30	2350	2211	672	546	SRC
W2-19-17-25- -NW	800600	REG. P1	42.7	U.FL.	7.90	120	59	49		0.70	0.92		389	389	2					1010	544	319	AESL, 1981
W2-19-17-25- -NW	830628	REG. P1	42.7	U.FL.	7.50	117	63	46		0.50	0.88		447	266	8					948	552	366	CITY OF REGINA
W2-19-17-25- -NW	800600	REG. K1	42.4	U.FL.	7.40	107	61	50		0.20	0.82		421	280	4	<1				924	520	345	AESL, 1981
W2-19-17-25- -NW	840724	REG. P1	42.7	U.FL.	7.50	126	57	40		0.50	1.00		440	260	6	<1				931	552	361	CITY OF REGINA
W2-19-17-25- -NW	670309	REG. P1	42.7	U.FL.		123	63	44	6.0				444	290	4				1100	974	564	364	MOLLARD, 1967
W2-19-17-25- -NW	660000	REG. K1	42.4	U.FL.		126	54	44	7.0		0.80		506	229	4				1000	971	539	415	MOLLARD, 1966
W2-19-17-25- -NW	800600	REG. K1	42.4	U.FL.	7.20	118	55	46		0.30	0.89		410	260	2	3.0				895	524	336	AESL, 1981
W2-19-17-25- -NW	800700	REG. P1	42.7	U.FL.	7.30	121	57	46		0.50	0.98		442	268	2					937	540	362	AESL, 1981
W2-19-17-30- -SW	800600	REG. R8	50.3	ISG	7.20	136	83	106		0.40	1.20		520	465	14	1.0				1327	680	426	AESL, 1981
W2-19-17-30- -SW	840724	REG. R8	50.3	ISG	7.70	160	89	126		0.30	0.72		554	512	20	<1				1462	760	454	CITY OF REGINA
W2-19-17-30-06-NE	750212	S-S 71-1	39.9	U.FL.	7.22	129	64	84	8.0	2.40	0.55		455	377	15	1.2	0.13	0.36	1300	1137	584	373	SRC
W2-19-17-30-12-SW	750212	C. NORTH W	59.1	ISG	7.51	166	86	136	9.0	4.30	0.48		593	561	14	0.1	0.06	0.43	1710	1570	765	486	SRC
W2-19-17-30-12-SW	750212	C. EAST WE	60.4	ISG	7.32	157	90	126	9.0	5.00	0.43		577	557	14	0.2	0.10	0.35	1700	1536	760	473	SRC
W2-19-17-32-05-NW	741001	IOL 021	33.2	U.FL.	7.24	174	84	86	8.0	2.00	1.03		542	502	7	3.0	<0.05	0.30	1570	1409	779	444	SRC
W2-19-17-32-05-NW	741001	IOL 020	32.0	U.FL.	7.29	171	84	86	8.0	1.30	1.32		545	491	14	3.0	<0.05	0.30	1550	1405	773	447	SRC
W2-19-17-32-05-SW	741001	IOL 018	34.1	U.FL.	7.41	171	82	91	8.0	1.40	1.31		542	500	14	6.0	<0.05	0.30	1560	1417	764	444	SRC
W2-19-17-32-05-SW	741001	IOL 024	33.5	U.FL.	7.27	190	84	108	9.0	1.10	1.61		553	575	7	4.0	<0.05	0.30	1650	1533	819	453	SRC
W2-19-17-32-12-SW	741001	IOL 025	45.5	U.FL.	7.27	166	83	85	8.0	7.50	1.24		542	474	7	5.0	<0.05	0.30	1550	1379	758	444	SRC
W2-19-17-32-15-NW	841107	P303	39.0	U.FL.	7.50	152	84	110	7.4	0.07	0.98		528	505	16	<1	0.08		(1)	1404	724	432	CLIFTON, 1985
W2-19-17-32-15-NW	850501	P303	39.0	U.FL.	7.60	165	75	98	11.0	0.10	1.44		495	460	12	<1			(1)	1318	720	406	CLIFTON, 1985
W2-19-17-32-15-NW	841010	P304	20.2	CONDIE	7.40	259	101	40	1.4	0.28	1.50		331	750	44	<1	0.07		(1)	1528	1064	272	CLIFTON, 1985
W2-19-17-32-15-NW	850502	P304	20.2	CONDIE	7.50	264	90	40	11.0	0.30	1.95		322	730	36	<1	0.07		(1)	1495	1032	264	CLIFTON, 1985
W2-19-17-32-16-C	850430	P104	14.0	CONDIE	7.60	166	63	35	11.0	0.20	0.24		347	372	56	<1			(1)	1050	676	284	CLIFTON, 1985
W2-19-17-32-16-C	821012	P104	14.0	CONDIE	7.70	160	55	38	8.0	<0.1	1.00		356	360	28	<4			(1)	1006	628	292	CLIFTON, 1985
W2-19-17-32-16-C	841105	P104	14.0	CONDIE	7.40	166	69	40	8.2	0.07	0.12		375	372	46	<1	0.07		(1)	1076	700	307	CLIFTON, 1985
W2-19-17-32-16-NE	841010	P307	36.8	U.FL.	7.10	154	100	94	7.4	0.13	1.30		608	474	14	<1	0.09		(1)	1453	808	499	CLIFTON, 1985
W2-19-17-32-16-NE	850514	P307	36.8	U.FL.	7.27	171	95	88	7.4	0.06	1.40		571	479	12	<0.02	0.02		(1)	1425	817	468	CLIFTON, 1985
W2-19-17-33-13-NE	841108	P103	13.7	CONDIE	7.30	176	74	41	8.9	0.16	1.00		375	520	16	<1			(1)	1212	744	307	CLIFTON, 1985
W2-19-17-33-13-NE	850515	P103	13.7	CONDIE	7.37	147	54	35	7.8	0.92	1.20		329	309	5	.0	0.06		(1)	889	589	270	CLIFTON, 1985
W2-19-17-33-13-NE	821006	P103	13.7	CONDIE	7.60	179	58	49	9.0	<0.1	1.10		383	436	14	<4			(1)	1129	688	314	CLIFTON, 1985
W2-19-17-33-13-SW	850508	P301	17.6	CONDIE	7.70	107	37	26	8.0	2.00	0.82		364	153	<1	<1	0.08		(1)	698	420	298	CLIFTON, 1985
W2-19-17-33-13-SW	841004	P301	17.6	CONDIE	7.50	104	48	34	5.9	0.15	0.76		413	194	4	1.0	0.07		(1)	805	456	328	CLIFTON, 1985
W2-19-17-33-13-SW	841107	P302	36.4	U.FL.	7.00	138	95	87	7.2	0.16	1.10		525	460	14	<1			(1)	1327	734	430	CLIFTON, 1985
W2-19-17-33-14-SW	850516	P310	17.2	CONDIE	7.46	107	44	30	6.6	7.60	1.20		348	201	7	0.1	1.10		(1)	754	446	285	CLIFTON, 1985
W2-19-17-33-14-SW	841015	P310	17.2	CONDIE	7.70	118	49	42	7.7	0.38	0.62		397	238	6	<1	0.04		(1)	859	496	325	CLIFTON, 1985
W2-19-17-33-15-NW	831000	H8	13.6	CONDIE	7.54	175	75	81	7.1	<0.1	1.20		537	375	20	<4		0.30	1470	1272	745	440	CITY OF REGINA, 1983
W2-19-17-34-05-NW	831000	H10	10.9	CONDIE	7.52	175	71	79	7.3	<0.1	1.40		539	355	22	<4		0.34	1430	1250	729	442	CITY OF REGINA, 1983
W2-19-17-34-08-NE	831000	H7	8.6	CONDIE	8.00	292	68	76	9.4	<0.1	1.90		337	800	19	<4		0.26	1750	1604	1008	276	CITY OF REGINA, 1983
W2-19-17-36-05-SW	750210		59.9	U.FL.	7.35	96	67	189	6.0	3.87	0.10		547	458	4	0.2	0.10	0.20	1460	1371	513	448	SRC
W2-19-18-03-04-SW	750212	U.H. 72-1	65.2	U.FL.	7.25	168	79	81	7.0	4.60	1.34		530	467	7	3.5	0.02	0.50	1450	1349	745	434	SRC

TABLE D - 1 WATER QUALITY DATA IN THE REGINA AREA

LAND LOCATION XX-XX-XX-XX-XX-XX	DATE YYMMDD	WELL NAME	WELL DEPTH M	AQUI-FER	PH	CA MG/L	MG MG/L	NA MG/L	K MG/L	FE MG/L	MN MG/L	C03 MG/L	HC03 MG/L	S04 MG/L	CL MG/L	N03 -N03 MG/L	P04 MG/L	F MG/L	COND. uS/CM	SUM OF IONS MG/L	T.H. MG/L	T.A. MG/L	REFERENCE
W2-19-18-03-05-NW	801215	MW17	22.9	CONDIE	7.50	235	87	59			0.47		386	670	34	<4				1471	944	316	BECKIE, 1980
W2-19-18-03-05-NW	801103	NW3	24.1	CONDIE	7.20	155	190	94			2.65		520	765	102	<4				1829	1168	426	BECKIE, 1980
W2-19-18-03-05-NW	801215	MW16	20.1	CONDIE	7.60	248	87	60			0.53		433	600	66	<4				1495	900	355	BECKIE, 1980
W2-19-18-03-05-NW	801216	MW15	16.7	CONDIE	7.80	275	113	49			0.04		534	680	48	39.9				1739	1152	432	BECKIE, 1980
W2-19-18-03-05-SW	801229	MW13	16.2	CONDIE	7.60	315	129	74		2.60	2.40		476	900	96	<4				1995	1320	390	BECKIE, 1980
W2-19-18-03-05-SW	801229	MW14	19.2	CONDIE	7.40	505	170	81		1.20	2.60		512	1550	76	<4				2898	1960	424	BECKIE, 1980
W2-19-18-03-05-SW	801229	MW12	12.0	CONDIE	7.50	387	160			<0.1	4.75		503	1120	132	<4				2307	1623	412	BECKIE, 1980
W2-19-18-03-11-SE	801216	MW18	17.4	CONDIE	7.70	286	120	44			0.10		405	700	130	141.8				1827	1208	332	BECKIE, 1980
W2-19-18-03-11-SE	801215	MW20	23.5	CONDIE	7.60	320	100	44			0.40		408	695	168	57.6				1793	1212	334	BECKIE, 1980
W2-19-18-03-11-SE	801103	MW6	24.1	CONDIE	7.70	117	120	42		1.30	0.60		354	536	30	<4				1201	784	290	BECKIE, 1980
W2-19-18-03-11-SE	801215	MW21	26.8	CONDIE	7.50	368	125	67		4.60	0.96		517	685	278	26.6				2072	1436	424	BECKIE, 1980
W2-19-18-03-11-SE	801103	MW7	29.5	CONDIE	7.50	142	162	55		2.50	1.56		410	572	134	<4				1479	1024	336	BECKIE, 1980
W2-19-18-03-11-SE	801215	MW19	23.4	CONDIE	7.60	304	112	47			0.34		350	775	124					1712	1220	287	BECKIE, 1980
W2-19-18-03-12-SW	750212	I.C. 58-1	29.6	CONDIE	7.20	207	60	31	7.0	0.10	0.71		368	477	29	1.3	<0.01	0.20	1380	1181	762	302	SRC
W2-19-18-03-12-SW	801103	MW10(ML1)	29.6	CONDIE	7.70	178	87	49					412	480	50	<4				1256	808	338	BECKIE, 1980
W2-19-18-03-12-SW	801103	MW9	26.5	CONDIE	7.90	128	104	46			1.20		393	476	18	<4				1166	748	322	BECKIE, 1980
W2-19-18-04-03-NW	850509	P306	17.8	CONDIE	7.30	114	52	20	8.0	3.70	0.86		359	220	14	<1			(1)	792	496	294	CLIFTON, 1985
W2-19-18-04-03-NW	841012	P306	17.8	CONDIE	7.70	117	52	32	5.9	0.19	0.77		370	216	12	<1	0.09		(1)	806	504	303	CLIFTON, 1985
W2-19-18-04-04-NW	850509	P305	17.7	CONDIE	7.20	112	34	20	8.0	0.60	0.88		344	190	6	<1			(1)	715	420	282	CLIFTON, 1985
W2-19-18-04-04-NW	841107	P305	17.7	CONDIE	7.40	98	55	26	5.7	0.16	0.74		383	205	8	<1			(1)	782	472	314	CLIFTON, 1985
W2-19-18-04-05-NW	850508	P102	16.5	CONDIE	7.60	272	86	44	11.0	0.70	1.60		350	715	34	23.0	0.07		(1)	1537	1024	286	CLIFTON, 1985
W2-19-18-04-05-NW	841105	P102	16.5	CONDIE	7.10	221	102	60	8.2	0.10	1.40		379	656	38	18.0	0.07		(1)	1484	972	311	CLIFTON, 1985
W2-19-18-04-05-NW	821006	P102	16.5	CONDIE	7.70	284	128	85	12.0	0.10	1.72		429	960	36	75.3			(1)	2011	1240	352	CLIFTON, 1985
W2-19-18-04-11-NW	850516	P309	55.9	U.FL.	7.19	173	96	92	7.9	2.80	2.60		547	530	12	.0	0.30		(1)	1464	826	448	CLIFTON, 1985
W2-19-18-04-11-NW	841107	P309	55.9	U.FL.	7.50	150	99	92	8.2	0.08	1.70		554	520	14	<1			(1)	1439	784	454	CLIFTON, 1985
W2-19-18-04-12-SW	831000	H2	14.9	CONDIE	7.40	179	77	86	6.9	<0.1	1.40		554	400	21	<4		0.50	1490	1326	763	459	CITY OF REGINA, 1983
W2-19-18-05-01-SE	821025	CCRL 009	42.7	U.FL.	7.60	174	88	100	9.0	0.90	1.50		592	512	14	<4			(1)	1491	800	485	CLIFTON, 1985
W2-19-18-05-01-SW	741002	CCRL 005	44.9	U.FL.	7.81	168	91	92	7.0	1.80	1.47		565	508	7	3.0	<0.05	0.35	1620	1445	794	463	SRC
W2-19-18-05-01-SW	821022	CCRL 005	44.9	U.FL.	7.60	168	83	84	8.0	0.70	1.48		562	488	14	<4			(1)	1409	760	461	CLIFTON, 1985
W2-19-18-05-02-NW	821013	P109	12.6	CONDIE	7.70	259	81	69	11.0	<0.1	0.50		386	640	94	13.3			(1)	1554	980	316	CLIFTON, 1985
W2-19-18-05-02-NW	850508	P109	12.6	CONDIE	7.50	283	56	62	13.0	0.80	0.29		366	595	100	7.0	0.07		(1)	1483	940	300	CLIFTON, 1985
W2-19-18-05-02-NW	841105	P109	12.6	CONDIE	7.40	444	146	118	14.0	0.05	0.24		439	1220	244	33.0	0.06		(1)	2658	1712	350	CLIFTON, 1985
W2-19-18-05-03-SE	850507	P105	13.1	CONDIE	7.70	163	38	24	10.0	2.30	0.81		350	286	10	<1	0.07		(1)	884	564	286	CLIFTON, 1985
W2-19-18-05-03-SE	820830	P105	13.1	CONDIE	7.80	59	82	40	9.0	13.00	0.10		310	312	8	<4			(1)	833	484	254	CLIFTON, 1985
W2-19-18-05-03-SE	841106	P105	13.1	CONDIE	7.20	234	63	36	9.3	1.10	0.70		379	530	24	<1	0.06		(1)	1277	844	311	CLIFTON, 1985
W2-19-18-05-04-NW	841106	P108	12.2	CONDIE	7.20	86	43	22	6.0	0.08	0.52		342	151	8	<1	0.08		(1)	659	392	280	CLIFTON, 1985
W2-19-18-05-04-NW	821013	P108	12.2	CONDIE	7.60	101	36	26	6.0	<0.1	0.17		342	152	8	<4			(1)	671	400	280	CLIFTON, 1985
W2-19-18-05-04-NW	850503	P108	12.2	CONDIE	7.90	114	24	23	7.3	1.80	0.55		329	154	6	<1	0.04		(1)	660	384	270	CLIFTON, 1985
W2-19-18-05-04-SE	850503	P106	15.4	CONDIE	7.60	378	108	36	14.0	0.30	0.45		320	990	128	18.0			(1)	1993	1390	262	CLIFTON, 1985
W2-19-18-05-04-SE	821022	P106	15.4	CONDIE	7.60	264	76	32	10.0	15.00	0.22		339	704	40	44.3			(1)	1525	972	278	CLIFTON, 1985
W2-19-18-05-04-SE	841106	P106	15.4	CONDIE	7.10	339	103	34	9.5	0.09	0.25		326	910	56	17.0	0.06		(1)	1795	1272	267	CLIFTON, 1985
W2-19-18-05-07-C	850507	P308	19.5	CONDIE	7.50	251	76	35	10.0	1.40	1.64		344	660	8	1.0	0.07		(1)	1389	940	282	CLIFTON, 1985
W2-19-18-05-07-C	841011	P308	19.5	CONDIE	7.50	221	98	38	7.5	1.20	0.01		362	630	6	<1	0.07		(1)	1364	956	297	CLIFTON, 1985
W2-19-18-05-07-SE	741002	CCRL 006	43.0	U.FL.	7.21	184	95	86	8.0	0.53	1.96		586	538	7	3.0	<0.05	0.35	1670	1510	849	480	SRC
W2-19-18-05-13-SE	750212		51.2	U.FL.	7.50	145	92	88	8.0	11.60	0.31		460	534	7	0.2	0.04	0.38	1480	1347	737	377	SRC
W2-19-18-06- -SE	830728	REG. R6	43.0	U.FL.	7.50	160	87	88		0.10	1.52		544	440	10	<1				1331	756	446	CITY OF REGINA
W2-19-18-06- -SE	830728	REG. R5	49.1	U.FL.	7.40	170	81	87		0.10	1.74		553	468	10	<1				1371	756	453	CITY OF REGINA
W2-19-18-06- -SE	800600	REG. R6	43.0	U.FL.	7.10	152	87	92		0.20	1.44		539	460	14	<1				1346	740	442	AESL, 1981
W2-19-18-06- -SE	840724	REG. R6	43.0	U.FL.	7.50	152	78	83		0.10	1.56		538	396	12	1.0				1262	700	441	CITY OF REGINA
W2-19-18-06- -SE	840724	REG. R5	49.1	U.FL.	7.50	170	87	80		0.10	1.86		548	432	12	<1				1331	780	449	CITY OF REGINA
W2-19-18-06- -SE	800600	REG. R5	49.1	U.FL.	7.40	157	87	83		0.10	1.65		547	480	10	<1				1366	752	448	AESL, 1981

TABLE D - 1 WATER QUALITY DATA IN THE REGINA AREA

LAND LOCATION XX-XX-XX-XX-XX-XX	DATE YYMMDD	WELL NAME	WELL DEPTH M	AQUI-FER	PH	CA MG/L	MG MG/L	NA MG/L	K MG/L	FE MG/L	MN MG/L	CO3 MG/L	HCO3 MG/L	SO4 MG/L	CL MG/L	NO3 -NO3 MG/L	PO4 MG/L	F MG/L	COND. uS/CM	SUM OF IONS MG/L	T.H. MG/L	T.A. MG/L	REFERENCE
W2-19-18-07-09-SE	831000	H5	26.7	CONDIE	7.28	198	62	24	5.9	<0.1	1.40		342	400	28	<4		0.19	1300	1061	749	280	CITY OF REGINA, 1983
W2-19-18-07-10-NE	831000	H28	26.2	CONDIE	7.67	135	54	16	6.4	<0.1	0.19		395	288	5	<8		0.12	1000	900	559	324	CITY OF REGINA, 1983
W2-19-18-07-12-NW	831000	H27	29.2	CONDIE	7.57	147	59	21	7.8	<0.1	0.59		344	388	16	<4		0.13	1040	984	609	282	CITY OF REGINA, 1983
W2-19-18-08-12-SE	831000	H21B	83.4	EMP	7.85	86	42	106	11.0	0.44	0.13		281	300	26	<4		0.38	960	853	387	230	CITY OF REGINA, 1983
W2-19-18-08-12-SE	831000	H21D	19.5	CONDIE	7.54	155	52	33	12.0	<0.1	0.32		259	430	10	<4		0.40	960	952	601	212	CITY OF REGINA, 1983
W2-19-18-08-12-SE	831000	H21C	52.2	U.FL.	7.78	102	49	90	28.0	<0.1	0.29		307	330	15	<4		0.62	980	922	456	252	CITY OF REGINA, 1983
W2-19-18-09-06-NW	831000	H23	18.0	CONDIE	7.32	266	61	43	21.0	0.19	1.00		310	680	6	<4		0.48	1270	1389	914	254	CITY OF REGINA, 1983
W2-19-18-12- -NE	800600	REG. BC166	14.6	U.FL.	7.30	104	46	9		4.10	0.12		205	254	2	<1				634	448	168	AESL, 1981
W2-19-18-12- -NE	840724	REG. BC166	14.6	U.FL.	7.40	163	41	6		1.20	0.90		338	276	14	<1				840	576	277	CITY OF REGINA
W2-19-18-12- -NE	660000	REG. BC166	14.6	U.FL.	7.70	152	40	9	4.0		0.90		412	255	4				880	877	545	338	MOLLARD, 1966
W2-19-18-12- -NE	800600	REG. BC166	14.6	U.FL.	7.40	139	45	10		3.10	0.83		337	264	4	<1				803	532	276	AESL, 1981
W2-19-18-12- -NE	800300	REG. BC166	14.6	U.FL.	7.20	147	42	8		15.00	0.88		349	268	2	<1				832	540	286	CITY OF REGINA
W2-19-18-12- -NE	830728	REG. BC166	14.6	U.FL.	7.50	154	43	8		3.30	0.87		298	276	10	<1				793	580	240	CITY OF REGINA
W2-19-18-12- -NW	840724	REG. BC-2	32.6	U.FL.	7.70	197	98	64		0.30	1.66		606	530	14	<1				1511	896	497	CITY OF REGINA
W2-19-18-12- -NW	830728	REG. BC-2	32.6	U.FL.	7.30	203	109	70		0.30	1.45		624	600	16	<1				1624	956	512	CITY OF REGINA
W2-19-18-12- -NW	660000	REG. BC-2	32.6	U.FL.	8.10	72	80	44		0.50	0.90		241	370	4				900	812	511	197	MOLLARD, 1966
W2-19-18-12- -NW	800600	REG. BC-K3	29.9	U.FL.	7.60	189	95	59		0.20	1.68		569	526	10	<1				1450	856	466	AESL, 1981
W2-19-18-12- -NW	660000	REG. BC-2	32.6	U.FL.	7.30	171	76	41					539	376	4				1250	1207	737	442	MOLLARD, 1966
W2-19-18-12- -NW	660000	REG. BC-K3	29.9	U.FL.	7.50	160	80	43					514	384	4				1250	1185	730	422	MOLLARD, 1966
W2-19-18-12- -NW	800300	REG. BC-K3	29.9	U.FL.	7.40	176	98	53		0.50			576	456	4					1364	844	472	CITY OF REGINA
W2-19-18-12- -NW	830728	REG. BC-38	48.8	U.FL.	7.50	114	57	42		0.60	0.67		436	238	6	<1				894	520	357	CITY OF REGINA
W2-19-18-12- -NW	800600	REG. BC-K3	29.9	U.FL.	7.50	165	96	57		0.10	1.52		560	480	6	<1				1366	808	459	AESL, 1981
W2-19-18-12- -NW	830728	REG. BC-K3	29.9	U.FL.	7.40	200	119	63		0.10	1.60		599	570	8	<1				1561	888	466	CITY OF REGINA
W2-19-18-12- -NW	800700	REG. BC-38	48.8	U.FL.	7.40	122	56	43		0.60	0.48		425	227	2	<1				856	488	348	AESL, 1981
W2-19-18-12- -NW	840724	REG. BC-38	48.8	U.FL.	7.80	118	58	40		0.60	1.36		433	240	6	<1				897	536	355	CITY OF REGINA
W2-19-18-12- -NW	660000	REG. BC-K3	29.9	U.FL.	7.70	165	77	41		0.20	1.20		517	382	7				1270	1190	727	424	MOLLARD, 1966
W2-19-18-12- -NW	800600	REG. BC-38	48.8	U.FL.	7.60	86	56	45		0.30	0.64		381	228	6	<1				803	448	312	AESL, 1981
W2-19-18-12- -NW	800600	REG. BC-2	32.6	U.FL.	7.30	187	91	71		0.30	1.62		489	560	8	<1				1408	844	401	AESL, 1981
W2-19-18-12- -NW	840724	REG. BC-K3	29.9	U.FL.	7.40	190	94	57		0.10	1.56		587	472	8	<1				1410	864	481	CITY OF REGINA
W2-19-18-13- -NE	800700	REG. BC-4	42.7	U.FL.	7.50	122	72	39		0.30	1.12		409	320	4					967	600	330	AESL, 1981
W2-19-18-13- -NE	800600	REG. BC-4	42.7	U.FL.	7.40	136	68	36		0.40	1.24		467	320	8					1037	620	383	AESL, 1981
W2-19-18-13- -NE	660000	REG. BC191	43.9	U.FL.		130	57	41	6.0	1.70	0.70		438	252	4					930	559	359	MOLLARD, 1966
W2-19-18-13- -NE	660000	REG. BC191	43.9	U.FL.	7.50	137	63	34	6.0				461	282	4					987	600	378	MOLLARD, 1966
W2-19-18-13- -NE	840724	REG. BC-4	42.7	U.FL.	7.70	146	69	34		0.40	1.10		472	300	6	<1				1029	648	387	CITY OF REGINA
W2-19-18-13- -NE	830728	REG. BC-4	42.7	U.FL.	7.40	141	74	39		0.40	1.08		475	292	10	<1				1032	656	389	CITY OF REGINA
W2-19-18-13- -SE	830728	REG. BC192	32.3	U.FL.	7.20	211	108	69		0.80	1.74		637	560	14	<1				1602	972	522	CITY OF REGINA
W2-19-18-13- -SE	840724	REG. BC192	32.3	U.FL.	7.40	211	110	65		0.70	1.60		632	560	14	<1				1594	980	518	CITY OF REGINA
W2-19-18-13- -SE	800600	REG. BC192	32.3	U.FL.	7.60	186	112	63		0.10	0.66		622	530	4	<1				1518	924	510	AESL, 1981
W2-19-18-24-02-SE	750210		33.5	U.FL.	7.20	198	94	50	7.0	6.30	1.56		601	484	3	<0.1	<0.01	0.40	1520	1445	882	493	SRC
W2-19-19-08-15-NW	750211		15.5	N/D	7.10	154	63	127	10.0	0.22	0.67		531	483	<1	<0.1	0.02	0.43	1450	1369	644	435	SRC
W2-19-19-31- -NW	670423	REG. P2	49.1	L.FL.	7.17	190	109	73	9				682	508	9					1580	925	560	MOLLARD, 1967b
W2-19-19-31- -NW	670424	REG. P2	49.1	L.FL	7.12	198	101	70	8	3.37	1.00		684	495	10					1570	912	561	MOLLARD, 1967b
W2-19-19-31- -NW	800600	REG. P2	49.1	L.FL.	7.30	165	113	66		3.50	0.71		656	492	12	<1				1508	876	538	AESL, 1981
W2-19-19-31- -NW	800600	REG. M1	42.1	L.FL.	7.10	168	92	70		2.70	1.44		600	452	6	<1				1392	864	492	AESL, 1981
W2-19-19-31- -NW	800600	REG. P2	49.1	L.FL.	7.40	176	105	74		1.60	0.78		666	488	6	<1				1517	872	547	AESL, 1981
W2-19-19-31- -NW	800300	REG. M1	42.1	L.FL.	7.30	170	102	75		3.00	0.75		646	436	6	<1				1439	844	530	CITY OF REGINA
W2-19-19-31- -NW	800600	REG. M4	28.7	L.FL.	7.40	181	106	66		0.70	1.12		571	506	14	<1				1446	888	488	AESL, 1981
W2-19-19-31- -NW	830728	REG. 14A	45.1	L.FL.	7.40	198	107	75		1.10	0.83		671	492	10	<1				1555	936	550	CITY OF REGINA
W2-19-19-31- -NW	660000	REG. 14A	45.1	L.FL.	7.60	193	106	70	8.0	5.80			678	480	4				1600	1545	915	556	MOLLARD, 1966
W2-19-19-31- -NW	830728	REG. M3A	33.7	L.FL.	7.40	126	68	45		<0.1	1.14		481	284	12	<1				1017	596	394	CITY OF REGINA
W2-19-19-31- -NW	800600	REG. M3A	33.7	L.FL.	7.20	131	78	46		<0.1	1.06		460	320	10	<1				1046	648	377	AESL, 1981

TABLE D - 1 WATER QUALITY DATA IN THE REGINA AREA

LAND LOCATION XX-XX-XX-XX-XX-XX	DATE YYMMDD	WELL NAME	WELL DEPTH M	AQUI-FER	PH	CA MG/L	MG MG/L	NA MG/L	K MG/L	FE MG/L	MN MG/L	CO3 MG/L	HCO3 MG/L	SO4 MG/L	CL MG/L	NO3 -NO3 MG/L	PO4 MG/L	F MG/L	COND. uS/CM	SUM OF IONS MG/L	T.H. MG/L	T.A. MG/L	REFERENCE
W2-19-19-31- -NW	800300	REG. M3A	33.7	L.FL.	7.50	122	80	42		<0.1	1.26		483	284	6	<1				1018	632	396	CITY OF REGINA
W2-19-19-31- -NW	840724	REG. 14A	45.1	L.FL.	7.30	186	99	70		1.20	0.82		653	448	12	<1				1470	872	535	CITY OF REGINA
W2-19-19-31- -NW	800300	REG. M2	26.3	L.FL.	7.60	117	75	51		0.20	1.26		510	262	4					1020	600	418	CITY OF REGINA
W2-19-19-31- -NW	800600	REG. M4	28.7	L.FL.	7.30	195	110	75		0.30	2.30		622	560	28	5.0				1598	940	510	AESL, 1981
W2-19-19-31- -NW	800600	REG. M3A	33.7	L.FL.	7.60	332	70	42		0.20	0.12		456	320	6	<1				1226	620	374	AESL, 1981
W2-19-19-31- -NW	660000	REG. M2	26.3	L.FL.	7.60	143	78	59			1.00		550	350	8				1200	1189	678	451	MOLLARD, 1966
W2-19-19-31- -NW	840724	REG. M4	28.7	L.FL.	7.50	158	96	70		1.00	0.58		538	440	10	<1				1314	792	441	CITY OF REGINA
W2-19-19-31- -NW	830728	REG. M4	28.7	L.FL.	7.40	170	90	63			1.62		553	440	12	<1				1335	776	457	CITY OF REGINA
W2-19-19-31- -NW	840724	REG. M3A	33.7	L.FL.	7.70	130	76	45		0.30	1.24		492	280	10	<1				1035	636	403	CITY OF REGINA
W2-19-19-31- -NW	840724	REG. P2	49.1	L.FL.	7.20	194	114	67		1.00	0.87		667	432	10	<1				1486	952	547	CITY OF REGINA
W2-19-19-31- -NW	800700	REG. M2	26.3	L.FL.	7.20	120	79	52		0.90	1.16		489	300	10	<1				1052	624	401	AESL, 1981
W2-19-19-31- -NW	660000	REG. 14A	45.1	L.FL.	7.70	190	104	73	8.0		1.10		555	543	10				1580	1484	903	455	MOLLARD, 1966
W2-19-19-31- -NW	800600	REG. M2	26.3	L.FL.	7.40	120	78	51			1.01		495	292	4	<1				1041	620	406	AESL, 1981
W2-19-19-31- -NW	660000	REG. M4	28.7	L.FL.	7.50	158	81	55	8.0		1.70		525	396	13				1300	1238	727	431	MOLLARD, 1966
W2-19-19-31- -NW	830728	REG. P2	49.1	L.FL.	7.40	190	104	72		2.70	0.76		676	480	10	<1				1535	904	554	CITY OF REGINA
W2-19-19-31- -NW	800600	REG. 14A	45.1	L.FL.	7.40	184	102	76		3.60	1.44		666	478	10	<1				1521	880	546	AESL, 1981
W2-19-19-31- -NW	800700	REG. M1	42.1	L.FL.	7.10	166	109	66		2.50	0.80		608	488	4	5.0				1449	864	498	AESL, 1981
W2-19-19-31- -NW	800300	REG. 14A	45.1	L.FL.	7.30	200	96	72		3.80	0.81		700	444	10	<1				1527	896	574	CITY OF REGINA
W2-19-20-05-04-NE	750211		49.4	L.FL.	7.20	162	89	61	8.0	6.00	2.48		599	410	7	<0.1	<0.01	0.45	1430	1344	770	490	SRC
W2-19-20-05-08-SE	750211		65.2	L.FL.	7.22	198	105	70	20.0	4.10	10.30		764	466	13	0.2	<0.01	0.35	1690	1651	927	627	SRC
W2-19-20-06-02-SW	750211		32.3	L.FL.	7.08	187	105	73	7.0	14.10	0.86		682	488	7	0.3	0.03	0.40	1550	1565	899	559	SRC
W2-19-20-06-09-SE	750211		54.9	L.FL.	7.06	199	99	70	7.0	7.85	0.86		711	475	<1	0.1	0.04	0.38	1540	1570	903	583	SRC
W2-19-20-19-12-SW	750212		56.7	L.FL.	7.12	182	103	43	7.0	0.02	<.01		621	446	18	3.5	<0.01	0.76	1450	1424	876	509	SRC
W2-19-20-20- -SW			9.1	N/D	7.55	200	200	81	6.0				570	790	130	5.0				1982	1323	467	RUTHERFORD,1967
W2-19-20-31-16-NE	750211		68.6	L.FL.	7.10	248	166	56	8.0	4.20	5.90		755	789	11	2.3	<0.01	0.49	2050	2046	1300	619	SRC
W2-19-20-36-14-SW	750211		80.5	L.FL.	7.15	362	224	151	8.0	11.80	1.11		888	1360	14	4.0	0.07	0.43	2900	3024	1822	728	SRC
W2-19-21-05- -SE			66.4	L.FL.	7.10	269	195	100	8.0				944	875	9	9.0				2409	1475	774	RUTHERFORD,1967
W2-20-16-17- -SW			55.8	N/D		62	48	575					543	1023	171					2422	352	445	RUTHERFORD,1967
W2-20-17-08-08-NE		FF1B	37.8	N/D		138	91	276		1.90	0.79		664	725	34	<1				1931	720	544	PROV. LAB
W2-20-17-20- -NE			30.5	N/D	8.15	127	51	500	7.0				1048	870	101					2704	527	609	RUTHERFORD,1967
W2-20-17-21- -N			45.7	N/D	7.60	167	89	97	7.0				584	456	15					1415	784	479	RUTHERFORD,1967
W2-20-17-21- -NE			88.4	N/D	7.10	138	98	123	8.0				561	525	16					1469	748	460	RUTHERFORD,1967
W2-20-17-24- -NW	800600	REG. R3	59.4	IGS	7.50	146	96	217		9.00	0.49		581	760	22	<1				1831	760	476	AESL, 1981
W2-20-17-24- -NW	830728	REG. R3	59.4	IGS	7.60	152	102	216		1.10	0.45		584	730	32	<1				1818	800	479	CITY OF REGINA
W2-20-17-24- -NW	840724	REG. R3	59.4	IGS	7.80	155	97	213		1.30	0.47		582	690	30	<1				1769	788	477	CITY OF REGINA
W2-20-17-24- -NW	800600	REG. R3	59.4	IGS	7.60	144	107	225		1.40	0.42		580	730	26	<1				1814	800	475	AESL, 1981
W2-20-17-32- -NE	800600	REG. W3	38.1	U.FL.	7.30	152	94	111		2.20	1.06		588	528	12	1.0				1489	768	482	AESL, 1981
W2-20-17-32- -NE	660000	REG. W3	38.1	U.FL.	7.50	171	90	89	9.0				580	495	7				1450	1441	797	476	MOLLARD, 1966
W2-20-17-32- -NE	800300	REG. W3	38.1	U.FL.	7.60	160	99	105		3.70	1.14		632	484	10					1495	808	518	CITY OF REGINA
W2-20-17-32- -NE	830728	REG. W3	38.1	U.FL.	7.60	173	92	110		1.10	1.18		606	528	14	<1				1525	812	497	CITY OF REGINA
W2-20-17-32- -NE	840724	REG. W3	38.1	U.FL.	7.30	173	91	107		1.70	1.00		594	504	16	<1				1488	808	487	CITY OF REGINA
W2-20-17-32- -NE	660000	REG. W3	38.1	U.FL.	7.70	163	92	88	9.0	2.90	1.00		573	498	8				1520	1435	787	470	MOLLARD, 1966
W2-20-17-32- -NE	840724	REG. W4	35.4	U.FL.	7.30	165	100	86		1.00	0.98		641	472	14	<1				1480	824	525	CITY OF REGINA
W2-20-17-32- -NE	800300	REG. W4	35.4	U.FL.	7.60	150	93	86		2.90	1.02		598	424	6					1361	760	490	CITY OF REGINA
W2-20-17-32- -NE	800600	REG. W4	35.4	U.FL.	7.20	149	86	95		1.60	1.00		565	448	10	<1				1356	724	463	AESL, 1981
W2-20-17-32- -NE	660000	REG. W4	35.4	U.FL.	7.40	164	87	86	9.0		0.50		559	468	7				1450	1381	765	458	MOLLARD, 1966
W2-20-17-33- -NE	800600	REG. W2	46.6	U.FL.	7.20	154	94	118		0.20	1.20		586	512	14	<1				1479	772	480	AESL, 1981
W2-20-17-33- -NE	840724	REG. W2	46.6	U.FL.	7.40	166	98	110		1.50	1.00		599	504	16	<1				1496	820	491	CITY OF REGINA
W2-20-17-33- -NE	840724	REG. W1	49.1	U.FL.	7.40	165	89	94		2.90	1.20		589	416	14	<1				1371	780	483	CITY OF REGINA
W2-20-17-33- -NE	800300	REG. W2	46.6	U.FL.	7.50	157	99	106		6.30	1.24		627	484	10	<1				1491	800	514	CITY OF REGINA
W2-20-17-33- -NE	660000	REG. W2	46.6	U.FL.	7.40	175	92	91	9.0		1.00		661	460	11				1550	1500	813	542	MOLLARD, 1966

TABLE D - 1 WATER QUALITY DATA IN THE REGINA AREA

LAND LOCATION XX-XX-XX-XX-XX-XX	DATE YYMMDD	WELL NAME	WELL DEPTH M	AQUIFER	PH	CA MG/L	MG MG/L	NA MG/L	K MG/L	FE MG/L	MN MG/L	CO3 MG/L	HCO3 MG/L	SO4 MG/L	CL MG/L	NO3 -NO3 MG/L	PO4 MG/L	F MG/L	COND. uS/CM	SUM OF IONS MG/L	T.H. MG/L	T.A. MG/L	REFERENCE
W2-20-17-33- -NE	800300	REG. W1	49.1	U.FL.	7.50	157	96	95		3.40	1.28		625	472	8					1478	788	512	CITY OF REGINA
W2-20-17-33- -NE	830728	REG. W1	49.1	U.FL.	7.60	178	85	98		1.10	1.28		595	496	14	<1				1468	792	488	CITY OF REGINA
W2-20-17-33- -NE	800700	REG. W1	49.1	U.FL.	7.40	152	113	91		2.00	1.15		588	512	14					1473	844	482	AESL, 1091
W2-20-17-33- -NE	830728	REG. W2	46.6	U.FL.	7.60	173	92	118		1.10	1.24		551	528	12	<1				1476	812	452	CITY OF REGINA
W2-20-17-33- -NE	800600	REG. W1	49.1	U.FL.	7.10	408	87	101		2.30	1.14		530	484	12	<1				1675	768	475	AESL, 1981
W2-20-17-35- -NW	830728	REG. R4	40.8	U.FL.	7.50	170	92	92		1.00	1.34		582	496	10	<1				1444	804	477	CITY OF REGINA
W2-20-17-35- -NW	800600	REG. R4	40.8	U.FL.	7.10	163	92	94		0.90	1.28		565	484	10	<1				1410	788	462	AESL, 1981
W2-20-17-36- -SW	830728	REG. R7	31.7	U.FL.	7.50	160	87	88		0.10	1.52		544	440	10	<1				1331	756	446	CITY OF REGINA
W2-20-17-36- -SW	800600	REG. R7	31.7	U.FL.	7.50	142	86	106		0.40	1.56		526	480	14	<1				1356	708	431	AESL, 1981
W2-20-17-36- -SW	840724	REG. R7	31.7	U.FL.	7.50	147	92	97		0.20	0.98		531	456	18	<1				1342	748	435	CITY OF REGINA
W2-20-18-08-09-NE	750211		33.8	U.FL.	7.36	132	67	65	7.0	2.80	1.39		476	360	1	0.2	0.03	0.42	1230	1113	603	390	SRC
W2-20-18-10-09-SW	831000	H13B	19.8	CONDIE	7.48	146	53	66	8.9	<0.1	1.10		393	320	14	<4		0.41	1230	1002	582	322	CITY OF REGINA, 1983
W2-20-18-10-09-SW	831000	H13A	42.3	U.FL.	7.47	125	61	73	6.5	<0.1	1.10		476	265	13	<4		0.30	1220	1021	563	390	CITY OF REGINA, 1983
W2-20-18-10-12-SW	831000	H240	29.7	U.FL.	7.54	101	56	47	15.0	0.37	0.29		383	230	9	<4		0.58	900	842	482	314	CITY OF REGINA, 1983
W2-20-18-11-12-NE	831000	H22	24.4	CONDIE	7.38	95	34	26	11.0	0.33	0.40		339	138	5	<4		0.45	690	649	377	278	CITY OF REGINA, 1983
W2-20-18-12- -NE	800600	REG. R2	35.4	CONDIE	7.20	176	73	25		0.50	1.56		338	462	30	<1				1106	740	277	AESL, 1981
W2-20-18-12- -NE	800300	REG. R2	35.4	CONDIE	7.40	181	75	24		0.60	0.82		354	440	26	<1				1101	760	290	CITY OF REGINA
W2-20-18-12- -NE	830728	REG. R2	35.4	CONDIE	7.40	210	77	25		0.50	0.86		355	512	60	<1				1240	840	291	CITY OF REGINA
W2-20-18-12- -NE	840724	REG. R2	35.4	CONDIE	7.30	206	81	23		0.30	0.88		351	476	64	<1				1202	848	288	CITY OF REGINA
W2-20-18-12-10-NE	831000	H26	27.3	CONDIE	7.71	169	82	79	12.0	<0.1	1.50		516	463	18	<4		0.27	1460	1341	759	423	CITY OF REGINA, 1983
W2-20-18-13-06-SE	750211	IPS. 67-1	60.4	U.FL.	7.53	114	58	4	5.0	11.80	0.90		278	308	4	2.0	0.04	0.27	904	786	522	228	SRC
W2-20-18-15-12-NW	780218	SRC R.530	38.3	U.FL.	7.64	91	34	13	4.2	0.27	0.60		314	128	5	.0	0.05	0.16	668	591	367	257	SRC
W2-20-18-15-12-NW	830831	SRC R.530	38.3	U.FL.	7.74	90	31	12	4.1	0.43	0.55		292	112	14	<0.2	<0.03	0.10	661	556	351	239	SRC
W2-20-18-19-01-NE	750212		51.2	U.FL.	7.30	138	60	64	7.0	3.00	0.97		456	361	<1	0.1	0.03	0.40	1240	1091	591	374	SRC
W2-20-18-22-07-SE	750211		60.4	N/D	7.37	227	96	327	11.0	1.13	0.21		617	1122	42	1.2	0.06	0.38	2490	2445	963	506	SRC
W2-20-18-24-01-SE	750212		57.6	N/D	7.05	122	62	59	6.0	1.60	1.23		455	310	<1	1.2	0.02	0.46	1180	1019	556	373	SRC
W2-20-19-23- -NW			26.2	N/D		192	92	112					862	347	23					1628	858	707	RUTHERFORD,1967
W2-20-20-13- -NW			25.3	N/D	7.10	180	70	41	5.0				520	410	11	17.0				1254	738	426	RUTHERFORD,1967
W2-20-20-16-02-SE	750211		131.7	EMP	7.49	106	47	611	8.0	7.76	0.19		633	1046	140	0.7	<0.31	0.35	2910	2600	457	519	SRC
W2-20-20-22-06-NE	750211		132.3	EMP	7.45	123	54	445	8.0	9.19	0.28		625	878	87	1.3	<0.2	0.35	2520	2231	531	512	SRC
W2-20-20-24- -SE			45.7	L.FL.	7.60	174	95	37	6.0				638	365	8	9.0				1332	826	523	RUTHERFORD,1967
W2-20-20-26- -SE			13.7	N/D	7.60	214	224	107	10.0				564	349	294	529.0				2291	1457	462	RUTHERFORD,1967
W2-20-20-27-04	750212		127.4	EMP	7.32	120	53	251	8.0	20.10	0.65		633	493	38	<0.1	0.09	0.30	1690	1617	515	519	SRC
W2-21-15-10-15-NW	750212		71.9	L.FL.	7.23	142	73	293	7.0	0.27	0.67		727	596	70	0.2	0.02	0.35	2010	1910	655	596	SRC
W2-21-15-32- -SE			46.9	N/D		155	100	499					1037	857	113					2761	798	850	RUTHERFORD,1967
W2-21-16-10- -NW			24.4	N/D		143	91	307					604	816	39					2000	733	495	RUTHERFORD,1967
W2-21-16-14- -SW			64.6	L.FL.		122	95	239					622	623	40					1741	696	510	RUTHERFORD,1967
W2-21-17-02- -NW			12.2	N/D	7.90	141	108	164	6.0				634	558	23	6.0				1640	797	520	RUTHERFORD,1967
W2-21-17-14-06-SE	750213		47.9	N/D	7.31	109	51	279	8.0	5.00	0.11		582	564	7	6.1	0.03	0.38	1780	1612	482	477	SRC
W2-21-17-22- -SE			19.8	N/D	8.00	183	80	176	8.0				665	620	35					1767	787	545	RUTHERFORD,1967
W2-21-17-32- -SE			36.6	N/D	8.34	49	32	117	12.0			12	231	255	48					756	254	205	RUTHERFORD,1967
W2-21-18-16-16-NW	730330		66.1	N/D	7.23	171	75	185	9.4	5.90			540	660	21	<1	<0.1	0.26	1680	1668	737	442	SRC
W2-21-18-26-02-SW	750211		17.7	CONDIE	7.28	492	342	167	17.0	0.74	0.03		314	2399	67	159.0	0.02	0.44	3860	3958	2630	257	SRC
W2-21-19-33- -SE			6.1	N/D		185	75	68					462	510	5					1305	770	379	RUTHERFORD,1967
W2-21-19-33- -SW			45.7	N/D		479	194	79					1971	374	114					3211	1996	1615	RUTHERFORD,1967
W2-22-16-25- -SE			2.4	N/D		64	28	44					207	66	24					433	278	270	RUTHERFORD,1967

TABLE D - 2 SELECTED WATER QUALITY DATA FROM LISSEY (1962)

LAND LOCATION		WELL NAME	DEPTH M	PH	CA MG/L	MG MG/L	NA+K MG/L	FE MG/L	CO3 MG/L	HCO3 MG/L	SO4 MG/L	CL MG/L	NO3 MG/L	F MG/L	TDS MG/L	T.H MG/L	TOT. ALK. MG/L	PHEN. ALK MG/L
W2-17-18-03-	-SW	BALGONIE	5.8	8.8	115	53	NIL	NIL	9	468	63	25	58.00	1.10	506	506	398	7
W2-18-10-10-	-SE	FARM	6.1	8.8	126	67	25	0.07	13	396	278	18	NIL	0.36	764	590	338	11
W2-18-17-12-	-SW	FARM	7.6	8.6	438	123	210	1.60	9	468	1480	95	1.20	NIL	2689	1600	398	7
W2-18-17-22-	-NW	FARM	6.1	8.7	192	80	32	0.07	13	274	537	17	NIL	0.10	1020	810	247	11
W2-18-17-23-	-NE	PILOT BUTTE	9.1	8.7	137	40	NA	0.11	13	231	223	27	55.00	0.32	671	507	212	11
W2-18-17-23-	-SE	GROC.	4.3	7.8	57	76	NA	0.08	NIL	551	NA	NA	4.55	NA	880	452	452	NIL
W2-18-17-30-	-NW	FARM	6.1	8.8	186	87	38	0.14	22	358	510	29	84.00	0.10	1144	822	330	18
W2-18-18-06-	-SE	FARM	10.7	8.4	126	47	NIL	NIL	13	221	196	36	38	0.32	651	507	214	11
W2-18-18-07-	-NW	TH#2-BI61	55.8	8.2	156	84	NA	0.45	5	688	240	15	0.70	0.05	990	735	572	4
W2-18-18-12-	-SE	FARM	15.2	8.4	142	63	81	5.10	13	495	305	30	NIL	0.42	907	616	428	11
W2-18-18-22-	-SE	FARM	22.9	8.4	82	33	NIL	0.44	13	234	69	13	7.20	0.28	430	343	214	11
W2-19-16-22-	-NW	FARM	12.2	8.5	154	67	435	2.30	30	470	1012	78	4.10	NIL	2112	658	436	25
W2-19-16-33-	-NE	TH10-BR60	16.8	7.6	134	85	NA	0.50	NIL	671	NA	NA	1.42	NA	1980	685	550	NIL
W2-19-17-24-	-SW	FARM	13.7	7.8	142	63	97	0.99	NIL	390	435	21	NIL	0.1	1088	616	320	NIL
W2-19-17-25-	-NW	K1	42.4	8.2	119	56	51	0.12	NIL	438	261	5	1.60	0.30	742	520	359	NIL
W2-19-17-32-	-SW	IOR	30.5	7.2	176	107	NA	1.80	NIL	488	NA	NA	4.40	NA	1250	835	400	NIL
W2-19-18-03-	-SE	TH#2-BR60	52.1	7.6	67	48	NA	NIL	NIL	56	NA	NA	0.26	NA	2100	364	46	NIL
W2-19-18-05-	-SW	CO-OP #6	42.1	7.0	184	124	NA	0.60	NIL	573	NA	NA	NIL	NA	1260	970	470	NIL
W2-19-18-12-	-NE	TH#1-BI61	46.3	7.7	206	105	NA	1.28	NIL	479	400	15	NIL	NIL	1160	945	393	NIL
W2-19-18-12-	-NW	TH#1-H61	33.5	7.6	117	170	NA	4.10	NIL	612	251	10	NA	NIL	1025	990	502	NIL
W2-19-18-12-	-NW	TH#2-H61	45.7	7.4	126	42	150	0.16	NIL	529	368	10	NIL	NIL	1006	485	434	NIL
W2-19-19-31-	-NW	PW#9G	35.1	7.2	129	76	NA	0.14	NIL	580	NA	NA	3.05	NA	900	632	476	NIL
W2-20-17-13-	-NE	TH#7-BR60	20.4	8.2	129	130	NA	0.80	50	437	NA	NA	NIL	NA	960	855	442	41
W2-20-17-21-	-SW	W.CLAY	45.7	7.2	164	115	NA	2.00	NIL	524	NA	NA	NIL	NA	1220	880	430	NIL
W2-20-17-22-	-NE	RCMP	54.9	7.4	324	363	NA	0.60	NIL	530	NA	NA	NIL	NA	2800	2300	435	NIL
W2-20-17-24-	-NW	EXHIB.	59.4	7.6	73	51	NA	0.40	NIL	66	NA	NA	2.10	NA	1400	392	54	NIL
W2-20-17-24-	-NW	TH#1-P61	55.8	7.4	161	142	NA	1.10	NIL	751	NA	NA	NIL	0.75	970	985	616	NIL
W2-20-17-26-	-NW	TH#8-BR60	61.0	7.5	146	96	NA	12.00	NIL	600	NA	NA	0.70	NA	1200	756	492	NIL
W2-20-17-27-	-NW	TH#4-H61	52.7	7.6	122	49	226	3.80	NIL	589	445	26	NIL	NIL	1235	505	483	NIL
W2-20-17-34-	-NW	TH#3-H61	46.3	7.7	97	81	188	1.70	NIL	510	505	28	NIL	0.26	1139	576	418	NIL
W2-20-17-35-	-NW	PW#R3	40.5	8.4	234	65	NA	1.76	5	384	510	NIL	NIL	NA	1220	850	323	4
W2-20-18-08-	-NE	TH#9- BR60	42.7	7.5	157	161	NA	0.71	NIL	594	NA	NA	2.21	NA	1250	1050	437	NIL
W2-20-18-12-	-NE	PW#R2	35.4	7.9	101	54	115	0.04	NIL	396	348	16	NIL	0.15	915	475	325	NIL
W2-20-20-28-	-SW	TH16-BR60	63.1	7.0	146	85	NA	2.80	NIL	594	NA	NA	0.72	NA	2240	714	487	NIL
W2-20-20-33-	-SE	TH3-MT29	39.6	NA	160	123	NA	10.00	NIL	488	780	188	NA	NA	2160	905	400	NIL
W2-20-20-34-	-SW	TH2-MT29	51.2	NA	220	133	NA	10.00	NIL	695	494	89	NA	NA	1660	1096	695	NIL
W2-21-20-20-	-NE	TH17-BR60	69.5	7.2	118	75	NA	0.16	NIL	637	NA	NA	0.88	NA	1720	602	522	NIL

NOTE: NA MEANS NOT AVAILABLE
NIL MEANS NOT DETECTABLE
CALCIUM AND MAGNESIUM DATA CALCULATED FROM HARDNESS DATA PROVIDED BY LISSEY (1962)
BICARBONATE AND CARBONATE DATA CALCULATED FROM ALKALINITY DATA PROVIDED BY LISSEY (1962)

APPENDIX E

CITY OF REGINA
PRODUCTION WELLS

APPENDIX E - CITY OF REGINA PRODUCTION WELLS

Notes

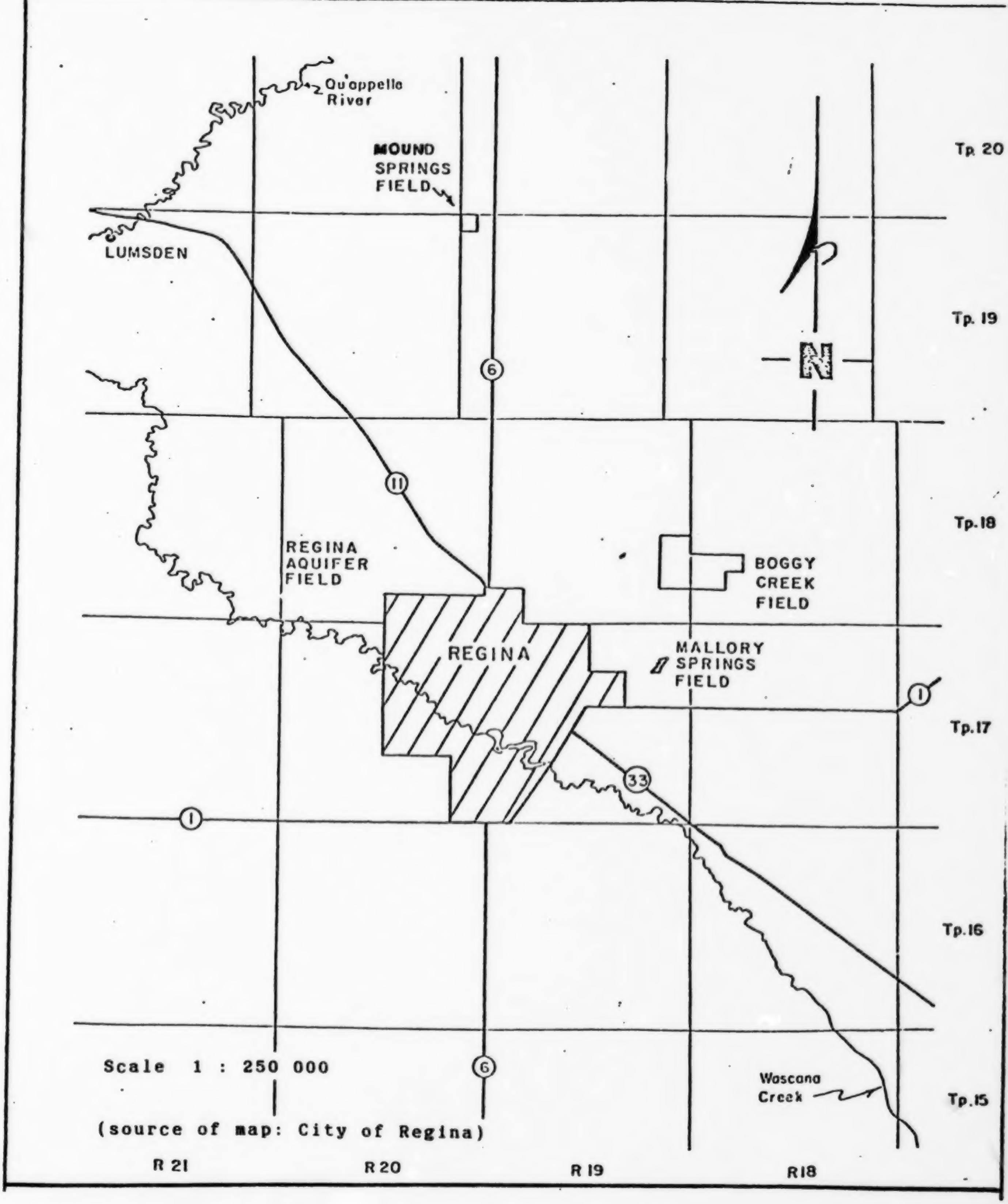
1. Table E-1 provides a summary of production wells that are or have been in use since about 1930. Some wells that were in use during the period 1930-1969 may have been missed due to lack of records.
2. For more detailed information on well construction, water levels, and water quality see the open-file report by Maathuis and van der Kamp (1985) or Appendices B and D of this report.
3. The well-field location maps are taken from the open-file report by Maathuis and van der Kamp (1985).

TABLE E-1 LIST OF PRODUCTION WELLS

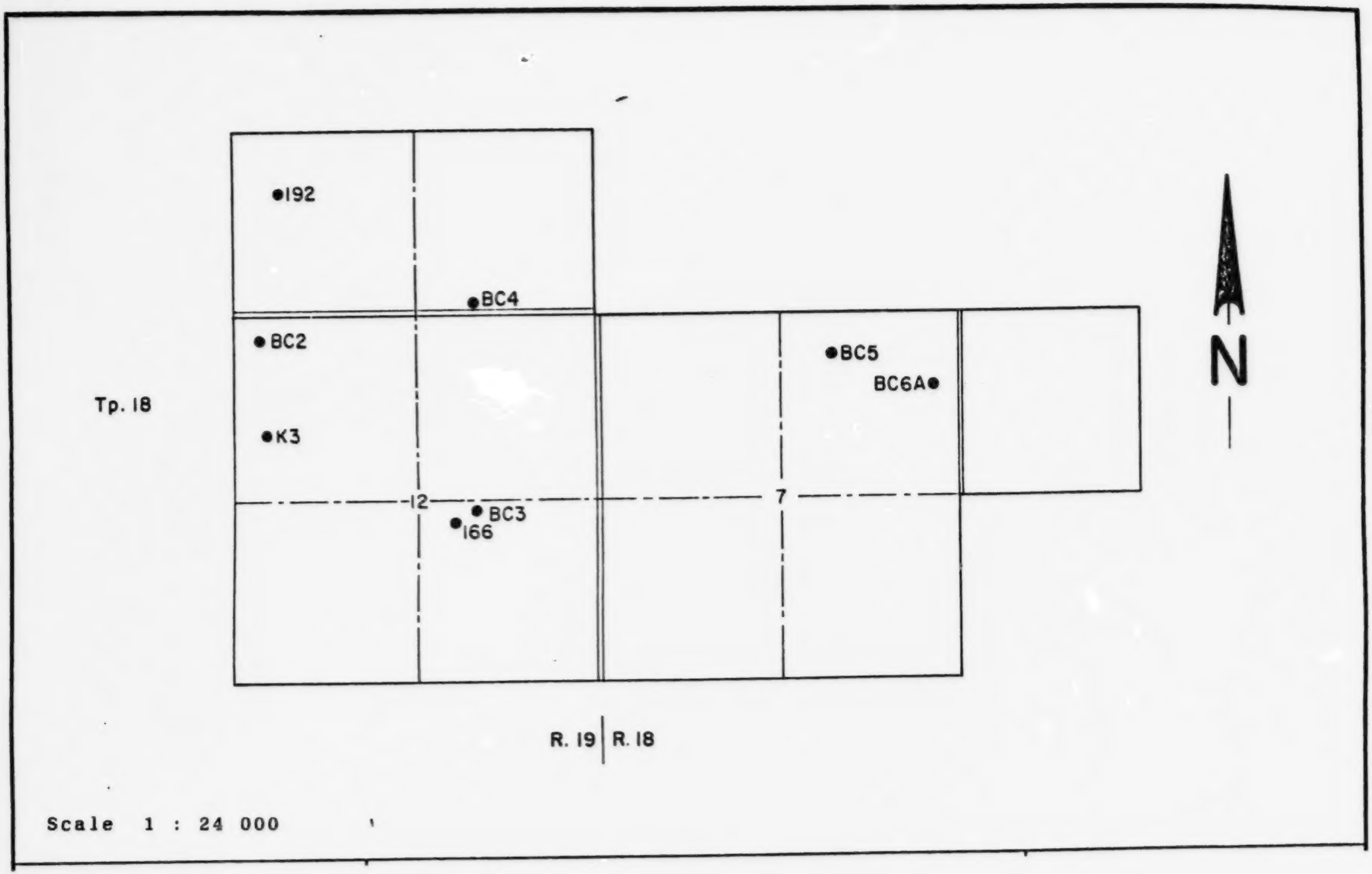
WELL FIELD	WELL NAME	LOCATION	DATE COMPLETED	DATE TAKEN OUT OF SERVIVE	REMARKS
BOGGY CREEK	BC-5	W2-18-18-07-NE	770426		
	BC-6A	W2-18-18-07-NE	820511		
	P-60	W2-18-18-07-NE	600630	1977	REPLACED BY BC-5
	NO. 178	W2-18-18-07-SW	350908	PRIOR TO 1969	
	K3(NO.168)	W2-19-18-12-NW	29		
	BC-2	W2-19-18-12-NW	6203		
	BC-3	W2-19-18-12-NW	62		
	NO.166	W2-19-18-12-SE	3007		
	NO.179	W2-19-18-13-SE	3509	PRIOR TO 1969	
	NO.191	W2-19-18-13-SE	440712	1976	REPLACED BY BC-4
	BC-4	W2-19-18-13-SE	760203		
	NO.192	W2-19-18-13-SW	490720		
MALLORY SPRINGS	K1	W2-19-17-25-NW	29		
	K2	W2-19-17-25-NW	29	PRIOR TO 1969	
	P1-H67	W2-19-17-25-NW	670304		
MOUND SPRINGS	9G	W2-19-19-31-12-SE	4409	PRIOR TO 1969	
	P2-H67	W2-19-19-31-14-NE	670422		
	14A	W2-19-19-31-NW	4008		
	M1	W2-19-19-31-NW	6209	1984	
	M2	W2-19-19-31-NW	6209	1984	
	M3	W2-19-19-31-NW	6210		
	M4	W2-19-19-31-NW	6210		
	M5	W2-19-19-31-NW	6210	PRIOR TO 1969	
	M6	W2-19-19-31-NW	620912	PRIOR TO 1969	

TABLE E-1 LIST OF PRODUCTION WELLS

WELL FIELD	WELL NAME	LOCATION	DATE COMPLETED	DATE TAKEN OUT OF SERVIVE	REMARKS
REGINA CITY WELL FIELD	WELL NO.2	W2-19-17-30-10	29	PRIOR TO 1969	IN CITY YARD
	C4	W2-19-17-30-NE	4808	1977	
	PD NO.1	W2-19-17-19-NW	5004	?	VICTORIA PARK
	PD NO.2	W2-19-17-30-SW	5806		4TH AVE CEMETERY
	R8	W2-19-17-30-SW	8211		
	R5	W2-19-18-06-SE	6801		
	R6	W2-19-18-06-SW	6802		
	R3	W2-20-17-24-NW	600822		
	W4	W2-20-17-32-15-NW	6112		
	W3	W2-20-17-32-15-NE	6202		
	W2	W2-20-17-33-15-NW	6303 ?		
	W1	W2-20-17-33-16-NE	6303		
	R4	W2-20-17-35-NW	610628	8404	
	R7	W2-20-17-36-SW	6802		
	W5	W2-20-18-04-NE	8304		
	R2	W2-20-18-12-NE	600707		

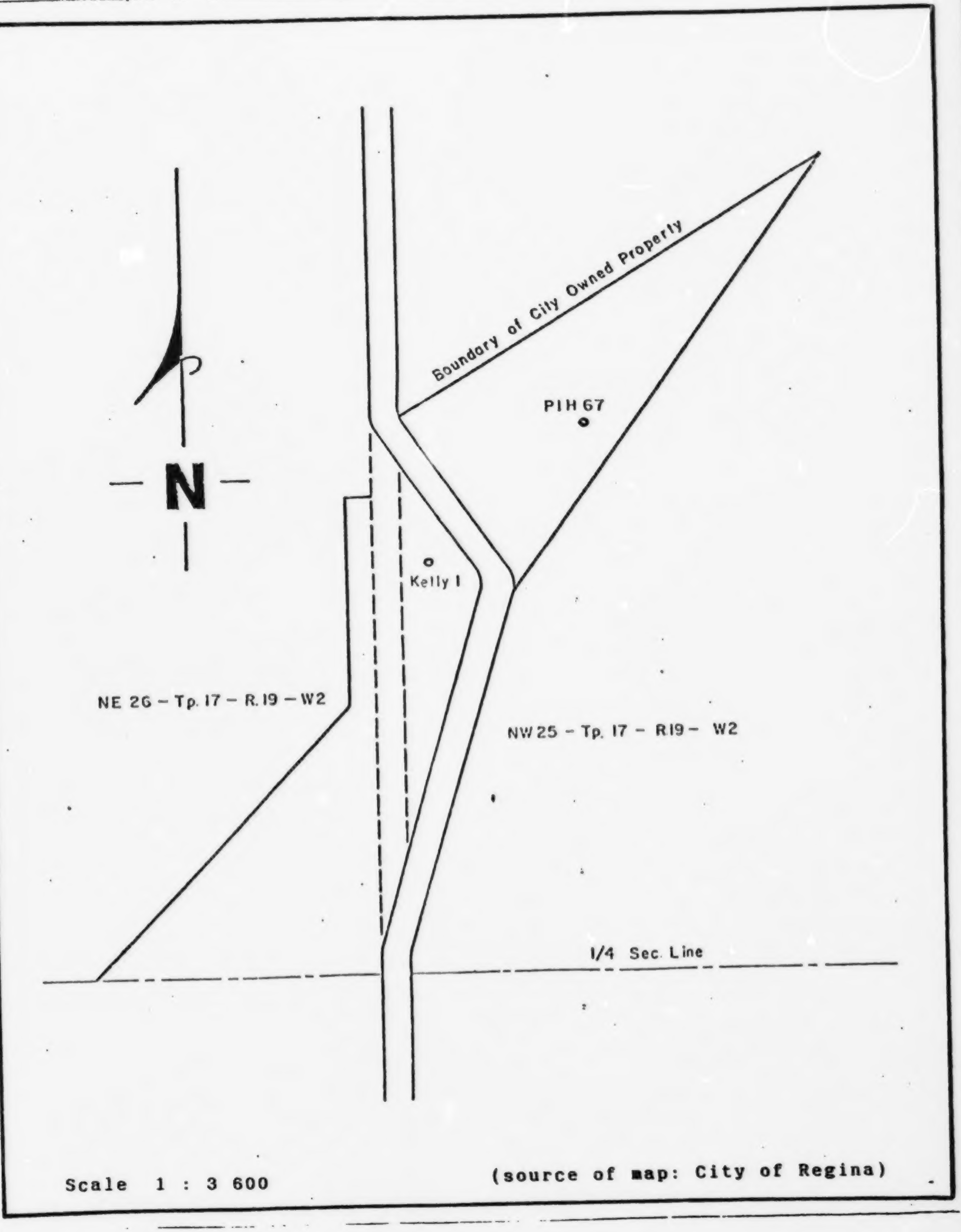

Qu'appelle River
MOUND SPRINGS FIELD
LUMSDEN
REGINA AQUIFER FIELD
REGINA
BOGGY CREEK FIELD
MALLORY SPRINGS FIELD
Wascana Creek
N
6
11
1
33
Tp. 20
Tp. 19
Tp. 18
Tp. 17
Tp. 16
Tp. 15
R 21
R 20
R 19
R 18
Scale 1 : 250 000
(source of map: City of Regina)

LOCATION OF WELL FIELDS.


N
●192
●BC4
●BC2
●K3
Tp. 18
12
●BC3
●166
7
●BC5
BC6A●
R. 19 | R. 18
Scale 1 : 24 000

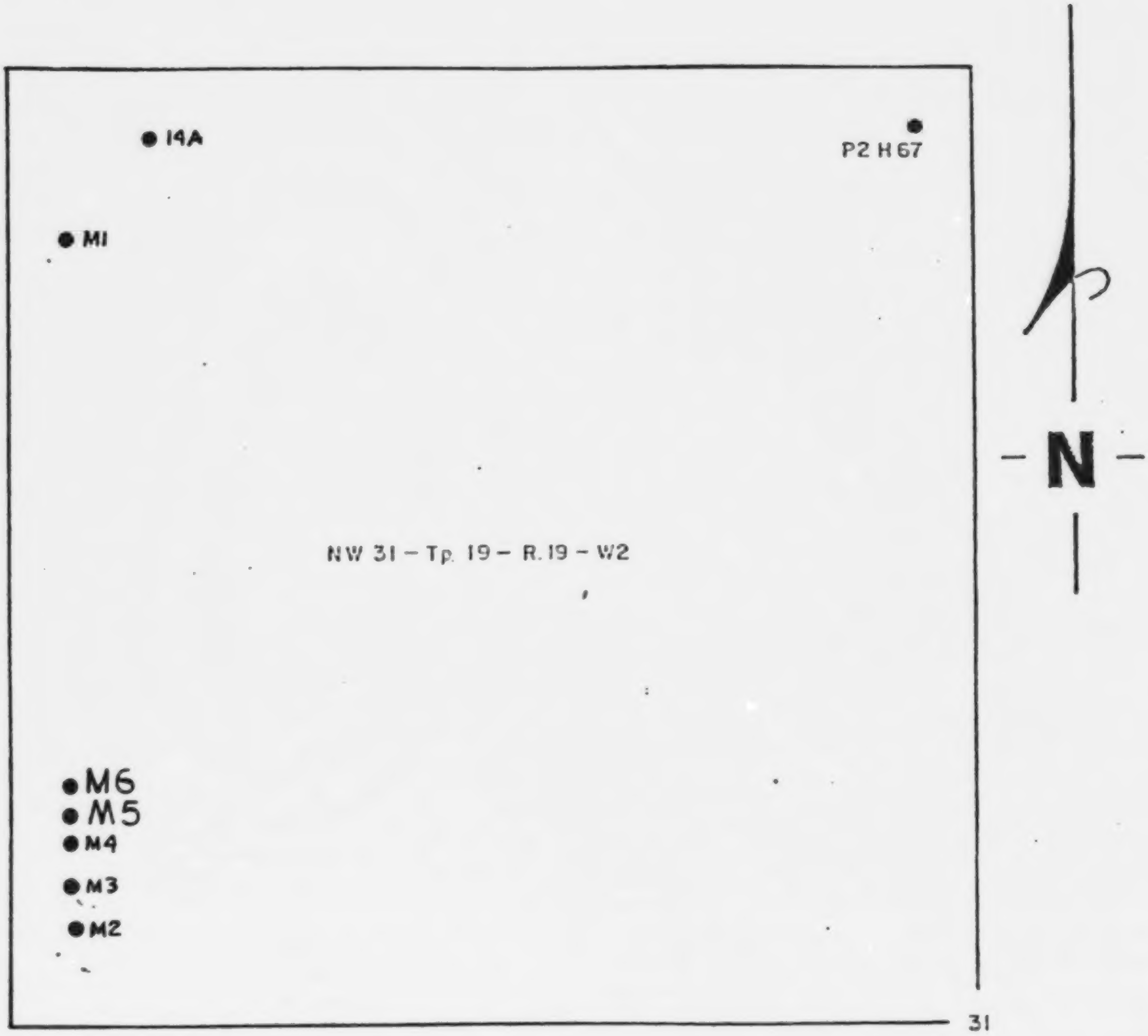
LOCATION OF WELLS IN BOGGY CREEK WELL FIELD.

(source of map: MLM Ground-Water Engineering Ltd., 1982)


N
Boundary of City Owned Property
PIH 67
Kelly I
NE 26 - Tp. 17 - R. 19 - W2
NW 25 - Tp. 17 - R19 - W2
1/4 Sec. Line
Scale 1 : 3 600

(source of map: City of Regina)

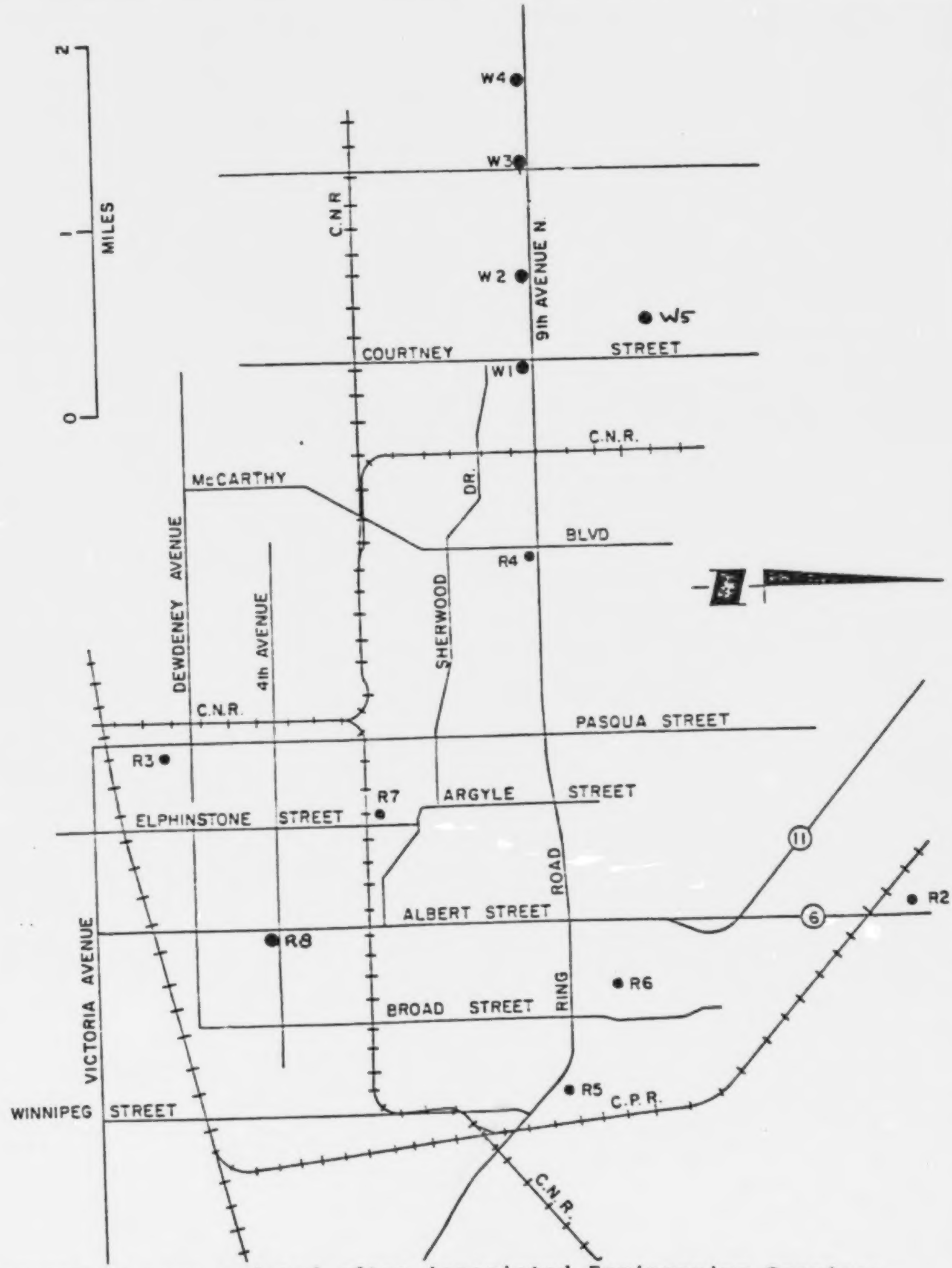
LOCATION OF WELLS IN MALLORY SPRINGS WELL FIELD.


14A
P2 H67
M1
NW 31 – Tp. 19 – R. 19 – W2
M6
M5
M4
M3
M2
31
N

Scale 1 : 6 000

(source map: City of Regina)

LOCATION OF WELLS IN MOUND SPRINGS WELL FIELD.


2
1
0
MILES
W4
W3
C.N.R
9th AVENUE N.
W2
W5
COURTNEY
STREET
W1
C.N.R.
McCARTHY
DR.
BLVD
R4
DEWDENEY AVENUE
4th AVENUE
SHERWOOD
C.N.R.
PASQUA STREET
R3
R7
ARGYLE
STREET
ELPHINSTONE
STREET
11
ROAD
ALBERT STREET
6
R2
R8
VICTORIA AVENUE
R6
BROAD
STREET
RING
R5
C.P.R.
WINNIPEG
STREET
C.N.R.

(source of map: updated after Associated Engineering Services Ltd., 1981)

LOCATION OF WELLS IN CITY OF REGINA WELL FIELD.

MAPS NOT

FILMED

CARTES

OMISES